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OF

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

PARIS, FRANCE, August 16th, 1900.

The Seventeenth General Meeting of the INSTITUTE, adjourned from Philadelphia May 18th, 1900, was continued as a joint meeting with the Institution of Electrical Engineers in the United States Pavilion at the Paris Exposition August 16th, 1900, under the joint chairmanship of Presidents John Perry of London, and Carl Hering of Philadelphia. The meeting was called to order at 9:30 A. M., by President Hering, who spoke as follows:

PRESIDENT HERING:—It gives me great pleasure to open this meeting, the first one held jointly by the Institution of Electrical Engineers and the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Such international meetings between societies whose aims are alike, but whose surroundings are different, cannot fail to be of interest and benefit to all who take part, and to draw closer together the different nations which participate, thus strengthening the ties which bind together the electrical engineers of different countries.

The promising success of the present session gives us reason to hope that it will soon be followed by other similar international meetings of electrical engineers.

In behalf of the members of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, I wish to thank you, Mr. President and Members of the Institution of Electrical Engineers, for the great pleasure you have given us by joining us in this international gathering. It was quite a venture for us to hold a meeting so far away from home; in fact, when I first suggested it some years ago, the proposition met with some ridicule by members of our board of managers. When we found, however, that our older and larger sister society in England joined us so heartily in our proposition, the success of our venture was at once as-

sured. I feel sure that those of our members who are present, and many who are not, hope that this, our first joint meeting, will be the beginning of a series of similar meetings of our sister societies, and that the next one will be in the home of our INSTITUTE.

[Mr. Hering then made a few remarks in French and in German, welcoming the guests from other foreign countries, and expressing the hope that the electrical societies of the leading countries will join in holding similar meetings, the next one of which he hoped would be in the United States].

In accordance with the arrangements of our Joint Committee, there will be two presiding officers. Prof. Perry, as the senior officer, will conduct the affairs of the meeting, and will now address you.

PRESIDENT PERRY, F.R.S.:—After a very few words from me we shall commence the discussion. I can only say to the Americans who are now our hosts in this building that their visit to England gave us very great happiness indeed for four days. I think that every Englishman who joined in the parties feels that it did really give us more pleasure than it was possible for our guests to experience.

There are no minutes to be read at the beginning of this meeting, because there have been no such meetings in the past, but minutes are being prepared of this discussion, and let us hope that they will be read on a future occasion. In the name of the two Institutions of Electrical Engineers, we welcome you, ladies and gentlemen, to this meeting.

I will now ask M. Mascart to say a few words.

PROF. E. MASCART:—I must first very cordially thank the Institution of Electrical Engineers for the exceptional honor bestowed, in naming me Vice-President; I have been greatly touched by this particular mark of esteem, and, I may add, of affection, on the part of the members of this society.

It was just now suggested that it would be very useful to have more frequent reunions similar to this; that is to say, meetings, including members of the electrical societies of the most important nations. You have begun by setting the example, and we thank you for having gathered together in Paris, the members of the two great institutions of America and England. We will agree to go to the United States; I assure you it would be a very great pleasure for me to do so, for I have very pleasant recollections of a journey there several years ago, but I am getting to be one of those who do not travel much. I hope nevertheless that the members of the French Society of Electricians, who are already considering that question, will respond to your invitation, and that very soon you will be able to hold in America, at Philadelphia, for example, a reunion of the societies of electricians of America, England, France and Germany, without counting other countries.

But if I cannot be one of you on that occasion, I shall accompany you, nevertheless, with my sincerest wishes for the success of your reunion.

Now, in the name of French electricians, in the name of the Society of Electricians, I thank you again very cordially, for choosing the city of Paris as the place to hold the sitting of your associated societies. I particularly thank our two honorable Presidents who took the fruitful initiative in this extra-territorial reunion.

PRESIDENT J. PERRY :—I will ask Mr. Ferranti to open the discussion.

A Topical Discussion at the Joint Meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers, Paris, August 16th, 1900, Presidents Hering and Perry presiding.

ON THE RELATIVE ADVANTAGES OF ALTERNATING AND CONTINUOUS CURRENT FOR A GENERAL SUPPLY OF ELECTRICITY, ESPECIALLY WITH REGARD TO INTERFERENCE WITH OTHER INTERESTS.

[A Topical Discussion.]

Mr. S. Z. de Ferranti:—I am indeed greatly honored by being allowed to open the discussion at this most fortunate meeting. I say most fortunate, because you will all agree with me that nothing could be better than that the American and English associations of Electrical Engineers should have a joint meeting. There is only one thing in my mind which is perhaps better, and that is that we should be holding this meeting in Paris, and thus show what a great tie really unites us all, and how much more friendly our feelings really are than is often supposed. The subject for this discussion was left for the English Institution to select, and I can assure you, gentlemen, that it was a matter of no little difficulty to decide upon what we should discuss. The subject which has been chosen you may at first think is simply a revival of the old contention between alternating and continuous current. I hope, however, that it is no such thing. Matters have greatly changed since the early days when the advocates of each of the two systems were, I may almost say, bitter enemies, and when they thought that everything that was done by the other side was wrongly done. We have all found that that is not so, and that there are great merits in the particular uses of both systems. But, as I have said, things have changed, and they have not changed yet as much as they are going to change in the future. The question that we have to deal with must be considered in the light of what electricity will be ten, fifteen, or twenty years hence. You have seen how the industry has grown; you know, by being members of the electrical profession, how much it has done up to now. I think few of us, although it is our life's work, realize what electricity is going to grow to, and how important and universal a part it is

going to play. It is, however, in this light that we must consider what are the best lines to be worked upon. It is no longer the small isolated systems which could be worked on one plan or another according to convenience; that we have to deal with, but it is the question of transmitting and using big powers all over large areas. Now, with regard to the advisability or desirability of one system, the continuous as against the alternating current: many of you know that I have consistently worked with alternating currents, and you will therefore appreciate that my knowledge of the other subject is not what it should be as compared with that of those who have worked more exclusively in that direction. I, however, desire to dissociate what I have done from what I am going to say, and rather than give so much my own opinion, I shall suggest a few points to you bearing upon what the general opinion is on this subject, as I consider it most important.

Looked at from the new point of view, this is what presents itself. Which will be the possible system in the future? I say "possible" because many of us have had very serious experiences of the electrolytic effects which are produced to such a large extent by the continuous current. What I am wondering is this: If this system is developed and extended to a very large extent, will it be possible satisfactorily to preserve any metal work in the earth at all? We have not only got to deal with the lead coverings of electric cables, but we have also any amount of structural ironwork—water mains, railway rails, gas mains, water pipes, and all sorts of things—the quantity of which is increasing every day in our streets all over the country. The amount of property invested underground in one or other of these forms is reaching a very great figure; and it becomes a serious question for us, not so much in the light of to-day, but in the light of the future, when immense developments will have taken place, to know on what lines we should go, and how best to protect this immense property, which may be injured by the otherwise beneficial work which we are doing. Of course alternating currents are not quite free from the liability to produce some harm, but what little harm they can do is not of commercial importance. Therefore I consider it will want our most careful thought and work and investigation to find out really how we can diminish these electrolytic troubles, due to continuous currents, or whether it will not be necessary to substitute alternating current, which produces but slight detrimental effects, and see how to overcome what disadvantages are now left to it. I hope that a great many of you gentlemen present will give us valuable information on this subject, and, after you have left this meeting, having heard the discussions which have taken place, that during the next few years you will give the matter your careful consideration, and then contribute your views through the electrical press, or by another such meeting as this, to the electrical profession at large.

Again, gentlemen, I must thank you for having been allowed to open this discussion. I hope it will be a full discussion, and that what I have said may stimulate discussion and lead to careful consideration of the subject which will prove beneficial to the electrical industry in the years to come.

MR. BION J. ARNOLD:—I wish to express my appreciation of the honor conferred upon me by being permitted, in this discussion, to follow so distinguished a worker in the electrical field as Mr. Ferranti. I did not know about my colleagues' intentions of calling on me this morning until late last evening, otherwise I would have taken time to prepare my remarks. We have all heard that the man who dares to assert that "electricity is in its infancy" is liable to annihilation on the spot; but after Mr. Ferranti's remarks I fancy we may be considered, for the moment at least, to be on the threshold after all.

I think it may bring out the discussion of this subject between the different countries, here represented, more thoroughly if I outline briefly the practice in the country which I come from, viz., the United States of America. For lighting work we started in our large cities with the direct current system as advocated by Mr. Edison. By the way, I once saw a letter from Mr. Edison, written some ten years ago, in response to an inquiry addressed to him asking his views on the relative advantages and disadvantages of the alternating and direct current. His letter intimated that he thought the alternating current was of Satanic origin, that it was a delusion and a snare, and that no good could come out of it. Mr. Ferranti has proven that the contrary is the case, and judging from his remarks and the work of many others it seems as though the ideas of his Satanic Majesty may yet prevail.

Returning to our subject, we started in our large cities with the direct current system and in our smaller cities with the alternating system. To-day the direct current seems to have not only held its own in our large cities, but, in addition, is replacing the alternating system in some cases, although the alternating system holds its place for smaller cities covering widely distributed districts and for transmission to the outlying districts of our larger cities. In the city of Providence, Rhode Island, one of the first and leading cities in the electric lighting industry, the alternating apparatus originally installed has been entirely thrown out, in the underground districts, and replaced with a direct current system of supply, delivering energy on a three-wire 480–240 volt system. The same thing is taking place in the city of St. Louis, Mo., although at that point they have not abandoned the use of the alternating apparatus, but a competing company has installed a direct current system on the 480–240 volt three-wire system, which company has largely taken the business of the alternating company within the district it reaches, and the net earnings and operation of the direct cur-

rent company have been very satisfactory. I mention these two important installations to emphasize my statement that the direct current is holding its own in our larger cities. I believe the alternating current will hold its prestige in our smaller cities and in the outlying districts of our larger cities.

In answer to Mr. Ferranti's advocation of the alternating current for lighting work in large cities, I will say that there is no means, so far as I know, for equalizing the load upon the power station when the alternating current is used, thus losing the advantages gained in direct current work when using storage batteries. The installation in the latter case would require less investment than would be necessary if the alternating current were used, assuming a reasonable area over which the energy is to be distributed.

Coming now to railroad work, we started with a 500-volt direct current system, and gradually increased to 600 and 700 volts, and are now utilizing the latter on the sections of the roads contiguous to the power houses, and driving our more distant sections with three-phase 25 or 30 cycle alternating current. I believe this will be modified, and that the alternating current will ultimately predominate in railway work. I believe that we shall soon eliminate entirely the sub-station, the rotary converter, and possibly the static transformers at the power house. We shall at least eliminate the sub-stations. Mr. Ferranti is no doubt working on this theory, and so also are others, in the respective countries here represented, including some from the United States. Some of us feel that there is a fair hope for success. It may, of course, be slow in coming, but that it will come I have no doubt. There are two main difficulties at present in the way of a complete and successful alternating current railroad system. The first is a lack of a practical method of starting and controlling the speed of an alternating motor without excessive consumption of energy. The second is the one pointed out by me when referring to lighting work, viz., the lack of a load equalizer corresponding to a battery in direct current work. Some of us are hoping for and endeavoring to develop a system by means of which we will utilize or have the advantages of an equalizing reservoir as it were, thereby taking the place of the storage battery in direct current railway work. I believe this is coming, and if it is successful we shall have an ideal system for long-distance railway work, utilizing all the advantages of the alternating current for transmission, and the advantages of the equalized load factor for economy, and we shall not have the disadvantages of the sub-station and its corresponding maintenance and labor expense.

I do not know that I can add anything more to the discussion, but if I have succeeded in pointing out, in a general way, the lines upon which the engineers of our country, and possibly of others, are working in the lighting and railway fields, it is all

I can reasonably hope to do in the time allotted to me. If any further information is desired regarding the details of the work to which I have alluded, I will, if the questions are asked, give such information as I can consistently at the present time.

Sir William Preece:—I feel somewhat in the same position as the blank leaf between the Old and the New Testament. I am here as a past President of the British Institution of Electrical Engineers, but I am also an Honorary Member of the Institute of Electrical Engineers of America. I therefore speak in the blank-page capacity. I also hold the position of never having compromised myself by associating myself either with the direct current or with the alternating current system. I have used both when I thought either was right. I believe there are circumstances in which the one is essential, and under different circumstances, where the other properly comes in.

Now, we want to consider the subject before us from different points of view. We have to consider generation, we have to consider the distribution of our currents, and we have to consider the transmission of these currents to great distances. In the first place, we have to deal with the generation of our currents, and there we start exactly from the same point, for we must remember than an ordinary dynamo is nothing more nor less than a simple alternator. So we start from the same basis.

Mr. Ferranti commenced his remarks by referring to some of the disturbances. He dealt with the electrolytic effect upon pipes and metallic coatings. There is another serious disturbance that has caused many of us anxious moments, and that is the disturbance produced by alternating currents upon telephones. I have always said the telephone is perfectly competent to take care of itself. The alternating current engineer need not worry himself about telephones. The telephone is never complete until it has worked on metallic circuit, and when that metallic circuit is tested and properly maintained, no alternating currents, whatever their frequency, whatever their strength may be, can possibly affect telephones. There is another serious difficulty that we have met with in our practice, and that is disturbances to railway signals. Although under ordinary normal conditions alternating currents cannot affect the railway signals, there may be sudden rushes to earth due to those strange effects that were once called, and rightly called, Ferranti effects, certain sudden effects of momentum in alternating circuits which raise the voltage so that the insulation is pierced by great surgings of current. Such things have produced, and will produce, false signals on our block system unless some step is taken to prevent them.

The rest of the disturbances are comparatively trifling in their frequency; but they have been serious in their consequences. There are the fires that have been caused by some of these surging effects to which I have alluded. Now, in determining the

necessity for the use of either system, we have not only to consider what I have said, but we have to consider the use to which it is placed. There is first electric lighting, next motive power, thirdly traction, and fourthly the transmission of power to a distance. I do not think there is a single man in this room who would not agree that the only practical and the only possible way to transmit energy to a great distance is now the triphase alternating current system. No high pressure continuous machine has yet been constructed which could possibly do what is being done between Niagara and Buffalo, and in California, and in Switzerland. There can be no question that for transmission the alternating currents must be considered pre-eminent.

As regards motive power, we come to quite another question. There is no doubt at the present moment that the triphase motor is as good as, if not better than, the continuous current motor under some circumstances. Mr. Arnold referred to the fact that in his country the continuous current was holding its own and displacing the alternating current. Here in France—I forget where at the present moment—there is an illustration, where continuous current machines have been removed, and replaced by triphase, in consequence of the superiority of the triphase over the alternating current. So we have this curious see-saw going on; at this side of the water the triphase supplanting the continuous current, on the other side the continuous current supplanting the triphase. The moral is, that each in its own sphere is good, and as both are used, there can be no serious defects in either the one or the other.

One of the most important questions which has not been raised, and which I should wish to raise, is that relating to the necessity of standardizing the frequency. I cannot perhaps remember all the cases, but we commence with Niagara. There the frequency is 25. There is another large installation where it is 45. In many places in England—and Mr. Ferranti himself has started one in the south of London—the frequency is 50. At Deptford, in an installation which he originated, the number is now 67. We come to the city of London, where I think it is 97 or probably 100. In our first alternating current systems in London we started at Sardinia street with 130. Now we find that the frequency is varying in different parts of the world from 25 to 130, and that shows that there is something wrong somewhere. I believe I am right in saying that the American engineers would have the standard for motive power 25, for ordinary distribution 50, and for house distribution, where each house has its separate transformers, 100. I think that is so, but I have no notes by me to refer to. Anyway, I want to point out that if this joint meeting can possibly do any good it will first allay the impressions that there is any difference among engineers as to the relative superiority of alternating and direct current systems; and secondly that now at this joint meeting we might determine a standard frequency that shall apply to various cases.

I have only one more point to make. That is to call attention to one line of progress along which we are working in England. I refer to the distribution of these triphase currents at high pressures to great distances by means of underground cables. Nearly all the experience in America is with overhead wires. The longest underground system which I know is the one established by Mr. Ferranti between Deptford and Trafalgar Square. This is nearly eight miles long. But underground mains to conduct high pressure triphase currents will be laid to a very large extent, and those engineers who will have the designing and manipulation of these must find out and learn all they can of the effects of capacity, for in all I have read and all I have seen that capacity is practically ignored. Everybody considers induction, which is small in its effects compared with capacity. I anticipate, when we get long lines of twenty or thirty miles transmitting triphase currents at 10,000 volts, great difficulty will be experienced in effects due to capacity.

Dr. A. E. Kennelly :—The occasion which presents itself today for the discussion of this subject is, as we have just heard from Sir William Preece, a most fortunate one, namely, for the expression of opinion as to the best frequency which can be adopted for alternating current systems as well as for the cure or dispersal of some of the mists which still hang over the precincts of the fields of alternating current and direct current supply. I think we are generally agreed, not only in America, but also, I think, here and in Europe as a whole, that where you have a densely crowded area to be lit by incandescent lights or arc lights you cannot do better than supply that area with direct current at the pressure at which it is to be operated ; and if the area is narrow and constricted, you need not exceed the pressure of a single incandescent lamp, or say about 100 volts. But as the area extends, the quantity of copper you put down becomes so large an item of the capitalization, that you must employ a greater pressure, say 240 or 250 volts, over a distance up to half a mile or a mile. When you come to a greater radius of transmission in your dense area you must employ 500 volts, and finally there arises a limit beyond which it becomes uncommercial to supply the direct current for the direct application, and you must introduce a higher pressure. To introduce this higher pressure you must resort to alternating currents, and so in many of the large cities of America you will find that the heart of the city is supplied by a direct current system on the three wire plan, and then the outlying regions of that same system are supplied through the medium of alternating currents at higher pressures. The pressure increases as the distance of transmission increases. We are all agreed that when the distance of transmission is considerable you must employ the alternating current. On that ground we all stand. Thus when you have to supply electric traction systems at a distance, you inevitably employ the alternating cur-

rent, and then you resort at the distant end, at least in America, to the direct current supply through the medium of converters. The connection together of those two systems is accomplished with difficulty as well as at considerable expense. There is a set of transformers to reduce the pressure, and then there is rotating machinery required to supply the direct current. This condition of affairs is so anomalous and inconsistent with the otherwise great simplicity of electric current supply, that it is difficult to understand how so remarkable a combination arose. I think it may be claimed to be due to the fact that the electric motor for tramways came into existence gradually and developed as part of a direct current system, and that up to the present time the standard traction systems of America have been all direct current systems. The difficulty of supplying all the apparatus needed upon an alternating current basis, even supposing there were no objections and difficulties to be met with in the alternating current motor, have constituted reasons sufficient to account for the anomalous condition of affairs. If, however, in the future the difficulties which remain in the way of introducing induction motor street-cars can be cleared away, we may expect, as I think Mr. Arnold intimated, that this condition will be eliminated, and we shall have nothing more than a plain alternating current system from beginning to end. The only considerable disadvantage would lie in the difficulty in maintaining a steady distribution of pressure. The difficulty which is encountered in the matter of the distribution of direct currents on electric railroad systems supplied from a distance is, as we know, the electrolytic difficulty. There has been much trouble in America on this account. Many pipes have been destroyed and others have been much damaged by this means. But that difficulty is giving way to careful and deliberate engineering, and it is a much less serious difficulty at the present time than in the past, because engineers know better now what to do. The damage has occurred not so much to large mains as to service pipes crossing the streets, and also to telephone cables where the metallic sheathing is continuous. By careful attention to these conditions, by studying the outlines of the system carefully, this electrolytic difficulty has been, and can be in the future, largely eliminated in maintaining a difference of potential between pipes and tracks not exceeding one volt within the danger area, by putting down a sufficient amount of ground-return copper, and by carefully bonding the tracks. This danger from the electrolytic action resulting in corrosion can be largely eliminated, and we may expect by engineering skill that this trouble will be almost entirely overcome.

One disadvantage, however, which has not been pointed out by preceding speakers in the direction of alternating current traction consists, I think, in the increased hazard from shock and increased danger to life and person. An accidental shock

from 500 volts of direct current is not, as a rule, a serious thing. There are cases on record, I believe, where it has proved fatal, but they are certainly very rare, and the number of shocks which are accidentally encountered from day to day over a large number of traction systems is considerable. If, on the other hand, you employ 500 volts of alternating current and get an accidental shock from that, the shock may be much more severe, because it would seem from recent experimental researches that the danger from shock is the danger of disorganizing the action of the heart. The danger in a shock from the direct current is in the first impulse, and may be recovered from; whereas, with the alternating current you get a succession of shocks which may be sufficient to disorganize the heart beyond all chance of restoration.

There are, of course, other outstanding difficulties with alternating current transmissions on railroads, but they are all seemingly of minor consequence. There is, for instance, the disturbance affecting the magnetic needle in general, and those of a magnetic observatory in particular. But it seems to me that the worst that can happen in that case is the banishment of the magnetic observatory from the vicinity of civilized communities to the more desert regions of the earth. While that may be a misfortune and an expense in particular cases, yet the aggregate advantage to the entire community of giving a traction system on the one hand, and removing an observatory on the other, does not appear to be worthy of comparison.

Professor W. E. Ayrton:—The special point to be decided at this discussion, as Mr. Ferranti brought out, is the relative advantage of the alternating and continuous current, especially with regard to interference with other interests. Interference is the main question we have before us in accordance with the title. There is no question whatever that we have had in various countries a very large amount of interference, and therefore I need not go into the details. Electrolytic interference Dr. Kennelly has referred to, as well as others, also telephone interference. A very serious kind of interference has grown up within the last two or three years, namely, interference with submarine cables. A very serious case happened in the Cape of Good Hope, where a large amount of damage was done, and there was considerable stoppage of messages coming by the Western cable to Europe. There has been interference with the magnetic observatories that Dr. Kennelly mentioned at the end of his remarks. There is no question about these interferences, but there is the question how are we to deal with them? Should you endeavor to destroy the attack, or should you allow the attack to remain and endeavor to improve the defence? Those are two totally different methods of dealing with the subject. In other words, should you endeavor to construct each undertaking in a way that it will not cause any interference with anybody else, or will you start with assuming that there is war? Are we to as-

sume that the other side are sure to attack us, and that they will not mind our losses and griefs, and all that we can do is to try to defend ourselves? To a certain extent both practices, both plans, have been followed, in Great Britain, at any rate. The Board of Trade regulations state that there shall not be more than seven volts difference of potential between any two points of the rails if the rails of the tramway are used as a return. That is an indication of an endeavor to prevent the enemy attacking us too much, allowing them to fire at us but not with expanding bullets, so to say. The regulation does not say how long the line may be with such a restriction, whether it is to be a long one or a short one. Still the seven-volt rule applies. Now, it has been shown conclusively that the seven-volt rule does not give sufficient protection. It certainly does not give sufficient protection in the case of a submarine cable which lands anywhere near the place where the tramway runs. It does not give sufficient protection in many cases as regards electrolysis, and obviously it would not give sufficient protection in any magnetic observatory which might be located in the neighborhood of the tramway. In the case of telephones it is possible to obtain a very good defence, and to make the telephone people more or less independent of attack. It was indeed the ease with which that defence can be constructed that led the Joint Committee of the House of Commons and the House of Lords, before whom the matter was brought a few years ago, not to interpose restrictions in the construction of tramways, because the conclusion they came to from the evidence they heard was that a telephone system in Great Britain was so shockingly bad in consequence of the use of the earth as a return—there was in fact so much interference of one with line with another—that even if there were no electric tramways at all, and no distribution of electrical energy on a large scale, it would be necessary for the telephone companies to resort to modifications. They would have to do that apart from electrical distribution, and therefore it was not necessary to restrict electrical distribution because telephones had to adopt their own defence. But regarding the water pipes and gas pipes that does not apply at all. They cannot use anything in the nature of an insulated "return" which will prevent electrolysis.

Now I come to a very important point which has not been suggested by any of the speakers so far—though perhaps I am wrong in saying it was not suggested, as it was implied by Mr. Ferranti—viz., that it would be very different if direct currents were used instead of alternating. But any doubt of the truth of that assertion has not been suggested by any of the speakers. If we were to adopt universally a general syste n of alternating currents, should we be free from electrolysis? This is a point which has been interesting me for some time past, and I was making some observations on that subject this year in Geneva, where they have suffered a great deal from damage in the pipes. The

matter was referred to me to investigate, and I will only remark that it is not at all clear that if only alternating currents were employed the pipes would be free from electrolysis. Some years ago I carried out experiments and showed an interesting one to certain people in my laboratory. I took an ordinary sulphuric acid voltameter, the Hoffman voltameter, with two tubes and a platinum electrode in each tube. The hydrogen was evolved in one tube and the oxygen along the other. We sent an alternating current through, and the same thing occurred as with a direct current, namely, the hydrogen came off in one tube twice as fast as the oxygen in the other. It is clear that we cannot assume that there will be no electrolysis because an alternating current is employed, and I find on this table a sample, of which I did not know previously, which has been sent by Mr. Trotter, of the Board of Trade, illustrating that very thing. The label says: "One of a pair lead pipes buried in a box of earth corroded by one ampere alternating current passing from pipe to pipe for six weeks." That is the result. That is not unlike the corroding seen in Geneva during my investigations. Mr. Trotter mentions in his letter that the specimen was corroded by an alternating current coming from Deptford. That does not mean that the Deptford current is worse than any other. He states that the current came from Deptford to show that it was not any fancy laboratory current. I admit that mine was a laboratory current, but it was produced at any rate by a Ferranti dynamo. The letter proceeds "to show it was no fancy laboratory current—I add it with regret, because Mr. Ferranti will argue, I suppose, that less damage is done by alternating than by continuous current. There are no more particulars to give except that the pipes are six inches apart and the sides where the currents passed each other are more corroded than the other parts."

It is clear, then, that alternating current will not give us protection with certainty, and it is clear also that it is a very important question to examine under what circumstances alternating currents do produce electrolysis, and under what circumstances they do not. That is a subject which has attracted a good deal of attention subsequently to my publishing the little experiment I told you about in connection with the voltameter, and I shall be very glad to hear from the meeting the results of any experiments which will enable us to settle what should be done with a lead pipe so as to make it, if possible, immune to action by an alternating electric current. For it is not possible to do that if such action occurs. If I polarize my platinum plates by means of a direct current first, then decomposition by means of alternating current takes places with perfect ease. I do not mean to say that the same amount of gas came off for a given number of coulombs, which would have come off with the same number of coulombs of direct current, but I mean when the observer saw the voltameter without looking at the ammeter at all, he saw no differ-

ence whatever between the hydrogen and the oxygen coming off with the alternating current as compared with that from the two separate tubes with the direct current.

Speaking now about the defence, about arranging our pipes (water and gas), and the submarine cables, so as to prevent the attack hurting us. In spite of what Dr. Kennelly said, I think more might be done to avoid the attack, and I am happy to say the London Tramway Companies have not looked at the matter at all from the drastic point of view that Dr. Kennelly has just suggested. The London Tramway Companies have *not* said: "We are coming. You have magnetic observatories near London. If we destroy them we are very sorry, and you had better go somewhere else." They have not taken that line at all. The line they have taken is: "Will you try and find out for us what we must do, the least we must do, to ensure you immunity from disturbance?" The result, as you know, has been that a Joint Committee was appointed by the Board of Trade to carry out experiments, and find out what was the magnetic disturbance produced by existing electric railways and tramways in Great Britain, when those tramways or railways worked under the Board of Trade regulations. When the difference of potential between the rails did not exceed seven volts, what was the disturbance? We found the magnetic disturbance very considerable and the seven-volts limit was quite impossible in the neighborhood of the observatory.

Without giving you a long account of all the experiments, I will give you practically the final result. The final result of the experiments and negotiations, for which we have very much to thank our British President and Professor Rucker, for they have taken a very active part in connection with these negotiations, has been this: Within two miles of the observatory the Tramway Companies offer to cut up their line into one-mile sections—that is to say, no part of the line in that neighborhood shall be electrically continuous for more than a mile, each mile being insulated electrically from the rest of the tramway system, and that current shall be brought to the trolley wire at the middle, and taken away from the rails at the middle of each mile section. Further, that no point whatever of the rails of any of these sections shall be allowed to differ from the potential of the earth by more than *one-fifth of a volt*. We have assured ourselves by calculation and by experiment carried out in different parts of London and Great Britain, that with such a difference of potential magnetic instruments will probably not be disturbed to an amount that will be practically serious; that is to say, by an amount that will interfere with the ordinary observations carried out in a good magnetic laboratory. So I am very happy to say that the tramways, although they are about to use American plant, have looked at the matter from what I may call in this case a *non*-American point of view. And instead of relying on

a supposed superior importance possessed by tramways over a study of the earth's magnetism, they have worked cordially with the Government's representatives in ascertaining what precautions must be taken to ensure immunity for the London magnetic observatories without introducing too much interference with the commercial working of tramways.

There is one other point with reference to alternating currents for electric tramways which has not been yet suggested. I was informed that one of the reasons why in the United States, alternating currents were not employed was because they found a difficulty in getting a good contact between a trolley pole and the wire when the wire had snow upon it, more difficulty, that is to say, with alternating than with direct current. Since that time, which was in 1897, certain electric railways have been constructed on the Continent of Europe which use alternating current, and it will be interesting if any one here can tell us whether any difficulty has been experienced in the winter when snow rested on the trolley wire; that is to say, more difficulty than would have been experienced had the direct current been employed.

Mr. Désiré Korda:—When distribution in a great city is in question, the alternating current, either single or three-phase, thanks to the ease of its transformation, offers advantages over the high-tension constant current, which demands for its transformation the use of rotary transformers. As to the single-phase current, the great objection which is often opposed to its adoption, is the difficulty of adapting it to motive power, the true motor for the simple alternating current not having yet been invented. It follows, in many cases, that one prefers to adopt the polyphase current, notwithstanding the difficulty of conveniently regulating the three bridges, and of maintaining their equal tension; recourse has been had sometimes to more or less complicated systems, polycyclal, or others.

It is on the question of polyphase currents that I wish to say a few words, or rather on a case in which their advantages and their inconveniences, as compared with the constant current, as revealed in a much more evident fashion; or the case of the distribution of power in a great factory, as for example, a large sugar refinery.

Polyphase currents, as you know, gentlemen, are spreading very rapidly for the distribution of power in such establishments, owing to the simplicity of the receiving apparatus, which requires almost no repair; on the contrary, for constant currents, the collector requires many repairs, and a degree of cleanliness difficult to obtain, especially in a place like the sugar refinery I mentioned, where one constantly meets with liquids more or less viscous, and dust which settles on the collector.

Very often I have had occasion to compare the two systems in making new plans, and I have then seen their respective advantages and inconveniences. The points to which I wish to call your attention are the following:

From the point of view of maintenance and repair and for the case I have cited, there is no need for hesitation; all the advantage is with the polyphase current But here is one inconvenience which presents itself. In a factory like that I have taken for an example, it is impossible to adopt currents of high tension chiefly on account of the viscous liquids and the dust of which I spoke; the degree of cleanliness that may be relied on is only relative, and the dirtiness which results, interdicts the use of high tension currents. Also, the management of the refinery limits the electrical engineer to a tension scarcely more than 200 volts, because the efficient tensions exceeding 200 volts for an alternating current, give as their maximum value, tensions which are already beginning to be considered dangerous. Then, too, in this refinery, we have to operate numerous motors, centrifugal sugar pans, for example, of great size, and these machines require a current of great quantity, especially at starting.

It is necessary to place conductors carrying heavy currents in channels or gutters. The proprietor of the refinery, for economical reasons, spends as little as possible for the channels, and prefers bare to insulated conductors. As one cannot twist together three bare cables as could be done with insulated cables in order to avoid the effect of self-induction, one is obliged to place them as near together as possible. But there is a necessary limit to their proximity both on account of the tension and the lack of cleanliness. Here then arises a new cause of wattless current for the electrical engineer charged with the plan of installation to consider, especially if the place of origin of the current be a little distant from the location of the motors. If it is, for example, at a distance of 200 or 250 metres, the self-induction of the line begins to play an important part in a workshop of considerable size.

To the increase in the quantity of the current proceeding from the counter electromotive force of the motors is added the fall of tension proceeding from the self-induction of the line.

Besides, in most cases a special machine for exciting is not allowed; the proprietor of the establishment saying to himself that if he had employed the direct current, the same machine would have furnished the exciting power, and there would have been no need for a special exciter. Planting himself on these considerations, he asks you to make an estimate including the exciter on the same machine with the generator.

From this results a third reason limiting you so far as concerns the voltage of the system. In effect, at the moment of the strongest charge of the alternator, the engine slows up; the exciter falls off also, and when one has the greatest need of voltage,

the exciter, to use a popular phrase, leaves us in the lurch. This diminution of the voltage is, in fact, as you can see, in direct ratio to the square of the diminution of the speed of the machine.

Thus there are three reasons why, for the applications of the class I have mentioned, one is obliged to choose a machine of greater capacity than one would use for a constant current.

Now let us see what remedies the day may bring forth. As you know, people have begun of late—and the Universal Exposition of 1900 made the first practical application—to concern themselves with the compounding of alternators. I think, indeed, in analogous cases, compounding is entirely indicated, and not only compounding, but over-compounding, for not only must one be able to compound the alternators, but it is necessary also to arrive at over-compounding in that which concerns the wiring in order to make headway against the loss of voltage arising from the self-induction of the motors. I believe that, in consequence, from the day when the application, of which we have had the first appearance at the Universal Exposition, shall become general, the polyphase current situation in comparison with the constant current, will grow better and better.

All that I have said has no bearing on the distribution of power by electricity in a large city; because in this case one has a high tension, and the fall of potential is proportionately very feeble; the quantity of current being small, the value of the counter electro-motive force is correspondingly feeble; besides the difficulties I spoke of will in some fashion cure themselves. But when one has a great workshop to serve, and it becomes necessary to employ large quantities of current under a low tension, these considerations I have named present themselves, and one is naturally compelled to take account of them.

Dr. F. B. Crocker:—I think now that the discussion has been opened, and the subject generally covered, that the time has come when we may confine ourselves to a few special points. The subject of our discussion is with regard to interference. I do not think that is the most important point, but as that is the subject we should apply our remarks largely to that. There are two interference effects that electric currents produce. I think they might be classified as the inductive and the leakage effects. Under the head of inductive I should include the magnetic effect, because the inductive effect is the magnetic effect, and vice versa. Now, the inductive effect of the direct current is purely magnetic, it produces only magnetic effects in its vicinity. Therefore its disturbing effect is upon magnetic apparatus in magnetic observatories or upon magnetic apparatus generally. But there are not many magnetic observatories in the world, and, as Dr. Kennelly observed, they might be relegated to a point where they would not be interfered with. It does not seem to me that the progress of the electric art ought to be in-

fluenced greatly by the existence of a few magnetic observatories, and certainly it would not be so in many places. So I should be inclined to agree with my fellow-member and dismiss that point as not very serious, to say the least.

The alternating current also has an inductive effect, viz., the production of currents in its neighborhood. It also produces a field, but that field being alternating produces no permanent effect upon magnetic apparatus. But the current inductive effect is produced solely by the alternating current, and that I should consider the more serious, because we have many more telephones or even telephone exchanges than we have magnetic observatories. As Sir William Preece has said, we can largely avoid that inductive effect by metallic circuits. But there are cases where we want wires overhead, and under those conditions we can hardly eliminate the inductive effect except by transposition of the wires, which is not a complete preventive. Furthermore, in certain cases and in smaller towns grounded circuits are used, and it seems to me that the inductive effect which produces a current in a neighboring conductor is a more serious disturbance than that of the production of a magnetic field. I think that is so at the present time, and I think it will always be so. Therefore I should say that on that account the alternating current is more guilty than the direct; in other words its disturbing effect without leakage is greater than that of the direct current. Now, the leakage effect, unfortunately, is much more serious with the direct current. The leakage of direct current is that which produces the electrolytic effect, and is the most serious interference that electric currents produce on other apparatus or other interests. But that leakage is something we can control to a great extent. The production of a magnetic field and the inductive effects are much more elusive than mere leakage. In high-tension conductors, overhead or underground, the leakage quantity is exceedingly small. It must be so. If considerable leakage occurred in an underground conductor at several thousand volts it would produce a short-circuit or a ground. But there is a leakage occurring in low-tension conductors. I think that is because we have allowed it to exist. If we insulate high-pressure conductors as well as we do, we can insulate low-pressure conductors equally well or better. I had occasion to test the underground network of New York City, many miles in extent, and the system was split up in many sections to enable this to be carried out. We found that the leakage was not excessive; it is a very small percentage of the current—considerably less than 1 per cent., as the test showed at the time. I am referring to electric lighting conductors which are not grounded. A similar result is found, I believe, by a comparison of the total output with the output that is useful. That shows that the leakage is a small quantity. In the gas industry that is not the case. A very large percentage of gas—10 or 20 per cent. in the case of

New York—is lost by leakage. But that is not true in electric distribution. So I should say that the fact that we have now in electric conductors, overhead or underground, a considerable leakage, is a temporary condition which can be overcome. I am sure electric conductors, except those purposely grounded, can be so laid that the leakage is a negligible quantity, even for long-continued electrolytic effects. Now, with the grounded trolley system, the single-wire trolley, the current must go into the earth. But there again by the use of improved methods, return feeders, and more perfect bonding, we have reduced that promiscuous flow of current through the earth, until now it is very much less than it was before, and I think it can be brought down to a quantity which is also insignificant. If it can be reduced to the figure which Professor Ayrton mentioned—one-fifth of a volt—if that were the difference of potential, it would be far below any dangerous electrolytic limit. So, apparently, the interference is not so very different in the two cases—that is to say, the alternating has a greater inductive effect without actual transfer of current, and the direct current has much more serious electrolytic effects. But those can be and have been largely overcome by more perfect construction.

I should like to say just a word on the motor question. Sir William Preece cited a certain instance where direct current machines had been replaced by alternating. I know of several other instances where alternating have been replaced by direct, so that evidence is not at all conclusive. That point alone could well occupy us for much more time than we have at our disposal. I will simply say now that so far as efficiency is concerned the two kinds of motors are almost identical. I have in my possession efficiency curves of the latest induction motors from the Westinghouse and General Electric companies, and I compared them with the efficiency curves of direct current machines of the same size, and the agreement was almost perfect; the two curves coincided almost exactly at full load and at all loads above one-third of full load. Below that the agreement was not so close.

A MEMBER:—What do you call the same size?

DR. CROCKER:—I mean in rated capacity, also in actual capacity. The agreement of the two sets of curves was remarkable and complete, except at very small fractions of full power the direct current motor has a better efficiency, but at one-half to full load the agreement was almost perfect.

SIR WILLIAM PREECE:—What was the efficiency in per cent.?

DR. CROCKER:—It depends on the size. The efficiency depends on the capacity of the machines. For example, a small machine, a one kilowatt alternating current induction motor, would have the same efficiency as a one kilowatt direct current machine between half and full power, and the curves representing that efficiency would agree exactly.

SIR WILLIAM PREECE:—What percentage of 100?

DR. CROCKER:—That depends on the size of the machine.

SIR WILLIAM PREECE:—Take one kilowatt?

DR. CROCKER:—I do not recollect that figure.

SIR WILLIAM PREECE:—Was it over 90 per cent.?

DR. CROCKER:—No, it was not; but we compare the two systems, and I say there is no choice in that respect, except that the direct current motor was higher efficiency at light load; at other loads the two are equal.

Now as to regulation for constant speed, the two machines are equivalent. A percentage of reduction of speed occurs when the machine is loaded from zero to full load. First-class direct and alternating current machines are equally good in that respect for constant speed; but when you regulate for variable speed the direct current motor has a great advantage over the alternating current motor. It is equal in efficiency, it is equal in regulation for constant speed, but the direct-current machine is superior for variable speed. That applies not only to stationary motors, with which I am most familiar, but it applies also to electric railway machines, and I think is equally important for stationary and for traction purposes. It is in that respect that the direct current has its advantage for power purposes over the alternating. I do not think it would be fair to the direct current or proper to this occasion to allow that point to pass unquestioned.

MR. W. M. MORDEY:—With several of our American visitors I have discussed during our meetings the question of earth drop on the return circuits of tramways, and I have found a general disposition to suppose the Board of Trade regulations restricting the drop within 7 volts was not adhered to and could not be adhered to. I have just carried out a very complete series of tests on many miles of tramways in England, and one of the things I had to investigate was that question of earth drop. I found in that system, running under the fullest load conditions, that the drop of potential never exceeded 5 volts. You will notice in tramway stations that the recording instruments which we always use, but which I think are not used in America, may momentarily indicate more than 7 volts; those instruments indicate higher momentary effects than the real value. For instance, if you suddenly switch one of those instruments on to a steady pressure of 6 volts it will usually swing to about 10 volts. One of the differences between English and American practice is, I think, apart from the question of scale, that great attention has been given to this question of earth drop and to the continuous recording of what is happening. The Board of Trade regulations are strictly enforced. I am sure the result has been good. I hope in this discussion we shall obtain from our American visitors some actual quantitative results arising from electrolysis. The real point which I think was intended to be brought out

was whether or not electrolysis, quite apart from other questions, would not be a determining factor in the development of systems of supply, at least where earthed conductors were used.

I will ask you to bear in mind the one and only absolute cure for all troubles of this sort, whether direct or alternating currents are used—the insulation of both conductors. I expect to find it applied in the future in all railway cases and in all conduit cases, whether for direct or for alternating current. Quite apart from the avoidance of electrolytic effects it has many advantages. To comply with Board of Trade regulations we have to use boosters and great quantities of copper to assist the return circuit. There would be no objection to 25 or 50 volts—or even more, instead of 7—if we had not to consider electrolysis. We could, if we wished—and if it were economical to do so—have as big a drop on our return as on our trolley line if we used an insulated return, and we should get rid of bonding and of sparking at dirty rails and of electrolysis. Information as to the results of the working of the double trolley system at Cincinnati, where it is or has been employed on a large scale, would be of great assistance to us. We should like to know if, in America, in your conduit or railway work, you are making any efforts to avoid the objectionable earth return.

Whether in the future there will be any preponderating system still seems quite uncertain. It may be the system is going to be alternating for transmission and direct for distribution, but I cannot help thinking that ultimate simplicity will lead to the use of alternating currents for almost everything, at least where we have long-distance transmission or large areas. In railway work where we begin with alternating currents, the simplicity of transformation will probably ultimately lead to the use of alternating throughout. There is, however, much to be said for Mr. Leonard's system, with his rotary converter on the car, if direct currents have any part. My own feeling, in spite of present fashions in England, is that sooner or later we shall have in all large systems the alternating current right through. I believe the rotary transformer is a make-shift, to be cleared away sooner or later for railway work; it is quite unnecessary for lighting and only indispensable for electrolytic work.

Some of you may go on to Switzerland from here and may see the examples of alternating work there. You will see the Burgdorf-Thun Railway and the Engelberg and Jungfrau Mountain railways, where many questions are disposed of. If you can start a train on a mountain rack railway you can start one anywhere.

We have, during the last few days, seen the Central London Railway, and highly appreciate the facilities afforded us by the company during our visit. But all of us who have had to do with the estimating of engineering work will have felt that if all the cost of those sub-stations—their static and rotary transformers

and so on, their first cost, their maintenance, their working cost in power and labor—could be realized and put into conductors, we should have, for that case at least, a simple system which would be safer and probably more economical in first cost, certainly in working cost afterwards.

The question of capacity has been referred to. It is more serious in alternating underground work than is generally realized. I recently had to investigate some difficulties due to capacity on a system of two hundred and fifty miles of underground cables in St. Petersburg. There is really much less difficulty than is generally supposed in overcoming most of the effects of capacity of such mains. I wish I had time to say more on the subject, but must leave it to an opportunity which I hope may be granted later.

I should like to refer to one "existing interest." I mean the interest of the public and of the scientific laboratories and observatories. There can be no question that ultimately these institutions will have to be removed from the centers of large populations where there are great applications of electricity, unless the methods adopted in those institutions can be so ordered as not to be interfered with by such applications. Fortunately we have at the Board of Trade a striking object-lesson. As far as I know, the Board of Trade electrical standards laboratory is the only electrical institution in England which is legally obliged to be accurate. It is laid out in such a way, the responsible officials say, that although they are in the heart of London they do not mind what electrical applications are made in London; their arrangements are such that they can carry on their work with the accuracy demanded by law without any reference to what is going on outside. That does not touch the question of measuring the magnetism of the earth. But surely that should be measured where it is the magnetism of the earth and not that due to the application of electricity to the use and service of man. There was a case in London of an institution, whose work I would not for a moment depreciate, where the influence of that institution was exerted successfully to prevent what would have been a very great convenience to the population of London, the running of an underground electric railway. It is difficult to speak calmly of such an action. There was no sort of proportion between the two interests; yet, though the object of the scheme was so excellent, the smaller interests were allowed to stand in the way of the benefit and the convenience of the population of London.

MR. C. O. MAILLOUX:—The subject has been so well discussed—it has been nearly exhausted already—that there is very little to be added. There is one point only which I think has not yet been fully discussed. In our country we would take a broader interpretation of the topic of discussion than is being taken here. The effects produced upon certain industries oftentimes effect the feasibility of the industry, and in this connection I have been

able to note the practical difference between the two systems, and the one which in fact determines the feasibility of either one, or its want of adaptability, according to the case. One of the important points, which it seems to me has been neglected, is the influence of the power factor in the case of the alternating current. My colleague, Professor Crocker, has pointed out quite clearly the similarity in results obtainable between the alternating and the direct-current motors. He has also pointed out that at constant speed they work quite alike. But he has neglected to note that the influence of the power factor on alternating currents is a matter of importance. As we know, when the electromotive force of the source of supply of a direct-current shunt-wound motor varies, the magnetic field of the motor varies, but that has the effect of merely changing the armature current to an extent necessary to maintain the speed; so that although there is speed fluctuation, it is not so great as when the electromotive force varies in the case of the alternating-current motor, because the speed is in this case a higher function of the electromotive force. In our country we have several isolated plants which assume the dignity and importance of central stations. It is not uncommon for us to have isolated plants of one thousand to three thousand horse power, which distribute energy over a zone of about half a mile radius. It is under such conditions that these difficulties are to be noticed. I remember an instance where a certain process for manufacturing coffee was employed, the electric current for which was furnished from a power station which also supplied lights to the district. It was found that owing to the enormous wattless current produced at the starting of the motors, on many occasions the line and even the generators would be overloaded, the result being that the current supply was cut off by the fuses blowing off, and that the machinery which was used in that coffee mill was put out of action, oftentimes at critical moments, when the stoppage meant great loss. The alternating-current motor system became absolutely inadmissible in this case from that circumstance, and had to be abandoned. One of the great objections, as you know, to the alternating-current motor of to-day is the fact that it takes such a large current at the time of starting. Its large wattless component is a serious matter, affecting, as it does, the working capacity of a line where the motors are constantly stopping and starting. Where all the motors are running together at an approximately constant load and at constant speed, the problem is simple, and there are no industrial reasons why the alternating current should not be placed upon an equal footing with the other. But where the motors are constantly stopping and starting, and especially where the distribution of power is constantly changing, and also where you load certain feeders more than others, the disturbance becomes very important. It has to be seriously taken into consideration by the designing engineer in laying out the plant. I

have had occasion to install a plant in a sugar refinery which required 2,000 H. P., and it was decided to adhere to continuous-current motors partly for these reasons, and also for the reason that in cases where variable speeds are required, and where the machinery is required to run at intermediate speeds, there can be no question that the direct-current system is at the present time the most suitable, if not indeed the only feasible one. I wish in this connection to speak of the pertinent remarks made by our French colleague in reference to one of the features, one of the industrial conditions, which oftentimes influences the selection of systems. I refer to the cost of the wiring. It is true that to-day, at least for the larger distributing conductors in buildings, and within a short radius, as well as for underground purposes (where we are obliged to use concentric or twisted conductors), the cost of the wiring is necessarily much greater than in the smaller branches and networks, such as the local lines or mains which run to individual motors. In our country the problem is, to some extent, solved, since we use iron conduits any way for these lines. Our insurance regulations prescribe, indeed practically compel, the use of iron conduits for the smaller lines, and, usually, we have two conductors, twisted or concentric, as the case may be, laid in iron conduits, whether the circuit work be used for direct or for alternating currents; but in the case of the larger conductors the arrangement need not necessarily be the same in both cases. With alternating current we must still use a twin or duplex conductor laid in an iron conduit, to keep down the reactance drop. With direct current there is no reactance, and we are not compelled to use twin conductors. It is often found to be very much cheaper to use two separate conduits, and two ready-made single conductors (especially in the case of the larger feeders or mains), than to use one single conduit very much larger in size and a cable specially made at relatively great expense. The mechanical difficulties in laying the larger conduits, their greater obtrusiveness and the greater space occupied by them, especially at bends, turns, offsets, etc., would be sufficiently objectionable even if they did not, as they do, in most cases, make the cost relatively greater.

PROFESSOR SILVANUS THOMPSON:—We have had no observations whatever upon the relative interference of alternating and continuous currents on board ship. It is of absolutely vital importance that there shall be no interference with the magnetism of the compass, and yet, extraordinary as it may seem, almost all ships that are equipped with the electric light are equipped with continuous current apparatus. I never could understand why that was. Some of the earliest vessels had alternating currents on a three-wire system, with the skin of the ship serving as a middle wire, but this system was succeeded by one with the very worst kind of continuous-current generator which could be put on board, viz., the bi-polar. I hope to see a complete revulsion in ship-fitting from this plan.

No reference has been made to the somewhat greater danger of fire that exists where conductors are carried through damp places if those conductors are served with continuous current. Electrolysis beginning at some leak will develop a current which eventually heats and destroys the insulation at that point, and thus originates a fire. With an alternating current you are less likely to have that occurrence. On the other hand, I suppose switch-makers will tell us that alternating switches are more expensive than continuous. No one has mentioned that while for arc-lighting admittedly there is some advantage in using continuous currents, for glow-lamps there is an advantage in using the alternating current. Not that there is any higher efficiency—that fallacy has long been disposed of—but if you use a continuous current for glow-lamp purposes, and the distribution is to take place over any large area, it becomes absolutely necessary to go to the high-voltage lamps working 200 to 250 volts. Now, any one who has taken the trouble to measure the reputed efficiency of high-voltage glow-lamps will know how inferior they are to the 100-volt glow-lamps; things which are supposed to be taking 3½ watts per candle being found actually to take 6, 7 and 8 watts per candle. I think there will be a great revulsion when the facts are known about the inefficiency of high-voltage glow-lamps. I prefer to have 50-volt glow-lamps; they are better in every way and last longer. This is impracticable with a continuous current, but with the alternating current it can be done where there are house-to-house transformers; and so, using low-voltage lamps, you can work to a much greater distance with alternating than with a continuous current.

I was sorry to hear Dr. Kennelly rake up the fallacy of there being a greater danger to persons from the alternating than from the continuous current. But that is a revival of a bit of the old electro-politics. When people wanted to damn the prospects of alternating currents and show how much better they were for electrocution, this was the line they took. I hope those arguments have disappeared. I think there is some evidence that the alternating current is not so dangerous as the continuous current; that the shock which is given by the alternating currents throws backwards the unfortunate person who receives it, and does not contract his muscles upon the conductor in the way that a continuous current does. The researches of Prof. H. F. Weber must not be overlooked. I prefer to leave that question to M. d'Arsonval, who understands these electro-physiological effects better than we electrical engineers.

Professor Ayrton raised the question of the electrolysis produced by the alternating currents. Might I point out that the question whether alternating current will, in any given circumstances, produce continuous electrolysis depends very largely upon the question of the relative area of the electrodes employed and the density of the current; because whether gas is disengaged at

that area or not during the period depends on the density to which that gas accumulates and whether it is given off. In fact the question whether the polarization becomes irreversible or not is very largely a question of scale.

Lastly, I will draw attention to certain points connected with electric traction on a large scale. I re-echo the suggestion of Mr. Mordey that it is well worth while for one who has not seen those electric railways in Switzerland to visit them, and to see how admirably the three-phase current is adapted for starting trains under the most severe circumstances possible. It is known from the experiments of Professor Carus-Wilson that the difficulty of the acceleration of the motor at starting is after all imaginary, and that it requires an extra percentage of current is also a fallacy. Every motor started upon a load takes more current than when running on that load, and this is true also of the tri-phase motor. The current required to produce rapid acceleration is even more important than the starting-torque, and the three-phase system, instead of being worse, is distinctly better.

We have had in London several recent object-lessons on electric traction. One of them has been, from one point of view, a gigantic success, but also a total failure. Little more than a year ago we were told that one of our millionaire railway companies had put down a sum of, I think, £30,000 to have experiments tried upon the underground railway. I referred nearly a year ago to this supposed experiment, and pointed out that the one experiment which was wanted for electric traction was to ascertain whether a three-phase motor arrangement would be better than a continuous one. We knew pretty well, but we wanted it tested, we wanted a verification. That experiment has not yet been tried. There were called in several engineers of the highest distinction, and they were aided by the constructional ability of Messrs. Siemens Brothers. But the only thing which has been tried, notwithstanding that all the resources of a great railway company stood behind the experimentation—I say it before Sir William Preece's face—all they have succeeded in doing is merely carrying out on a large scale what was done at Gross Lichterfelde, by Siemens and Halske, fifteen years ago, viz., establish the fact that you can drive by the continuous current, using conducting rails put beside the ordinary rails. The London press has pronounced this experiment to be a perfect success. I regard it, on the contrary, as an abject failure, inasmuch as it gave us no further information.

Lastly, if you are going to have, as I think we shall have, trains running at 100 or even 150 miles an hour, driven electrically, there will be no chance of success if we have to depend upon a motor which has got a commutator upon it. I speak of a new growing interest, viz., exceedingly rapid transit, and I venture to say that for exceedingly rapid transit the only chance of possible success is to take advantage of that which is the finest

thing of all in electrical engineering, the perfect flexibility and adaptability to requirements afforded by the current when that current is an alternating one.

MR. H. WARD LEONARD:—I have a fair acquaintance with what can be accomplished with the continuous current as regards large starting-torque with a small amount of energy, and have given considerable attention to the operation of large motors which have to be started under very heavy loads, and operated at different speeds and reversed.

I have lately seen one of the recent installations employing three-phase motors upon railway work in Switzerland, and I must say that when the car was started it seemed to me as though there were about one donkey-power doing the accelerating. It did not convey the impression to my mind of being able, with moderate power, to produce the heavy starting-torque required for the rapid acceleration which is such an important factor in electric railway work and many other important applications of electric motors.

Perhaps my views on this point are a little biased, but it seems to me that when we consider large railway motors the most important points are: rapid acceleration, small starting energy, perfect and simple control and ease of reversing, and the restoration into the circuit of the energy at present wasted upon the brakes.

We find the possibility of obtaining all of these points in the continuous current to a degree to which there is no promise as yet in the alternating current.

When we consider the question of electrolysis, we are met with difficulties in attempting to use a continuous current in the ground return circuit, which seem insuperable except by capital expenditures which are entirely uncommercial.

When we wish to transmit very large amounts of energy over the long distances which are desirable, we all agree that the alternating current is the only suitable one for the purpose.

These considerations have, for many years past, made me believe that we ought to use the alternating current for the generation and transmission of our energy, and that we should have upon the moving vehicle some means of transforming the alternating current into a continuous current of controllable E.M.F., and that we should use this continuous current of variable E.M.F. for operating the propelling motors at the variable speeds required in practice.

These arrangements would give us large starting-torque with a small consumption of energy, and even in the case of the largest motors will give perfect control at any desired speed and simplicity in reversing. It eliminates all difficulties due to the electrolytic action of the continuous current in the ground circuit. It gives us the power to employ motors of practically unlimited power at practically unlimited distances for railway and

other variable speed uses, and entirely eliminates the expensive and inefficient sub-stations of to-day.

It seems to me that the electric railway is the application of electric power which is going to exert the determining influence upon the methods of using electric energy in the future, especially the railway motors of very large size; and it seems to me a significant fact that, after twelve years of development by the leading engineers of all countries, there are no alternating current motors exhibited at this exposition for railway service or any other duty having similar requirements.

PROFESSOR PEERY:—Mr. Carl Hering, M. Mascart and I waive our right to say anything on this question, although we could, of course join heartily on one or other side. I beg to say that we think it better to have no vote upon this discussion as it is an incomplete discussion—one which is adjourned. The specimen sent by the Board of Trade will be on view in our room in the British Pavilion.

At the conclusion of the discussion, brief references to cetrain objects possessing special or novel interest in the electrical sections of the International Exposition were made successively by M. Hospitalier, Major-General Webber, Mr. Gavey, and Mr. Hering.

REPORT OF DELEGATION OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS TO THE INTERNATIONAL ELECTRICAL CONGRESS HELD AT PARIS, FRANCE, IN AUGUST, 1900.

To the Executive Committee and Council of the
American Institute of Electrical Engineers.

Gentlemen:

The following is the report of the delegates officially representing the American Institute of Electrical Engineers at the International Electrical Congress held in Paris, in August, 1900.

It had been voted, at the regular Council meeting of March 28th, 1900, that the President of the Institute in office at the time of the holding of the Electrical Congress should be the official delegate of the Institute to that Congress; and that he should be authorized to appoint such additional delegates as he might deem advisable. Under this decree, Mr. Carl Hering became the official delegate, by his election to the Presidency in May, 1900; and in June, 1900, he appointed the following additional delegates:

Dr. W. E. Goldsborough, Wm. J. Hammer, Dr. A. E. Kennelly, C. O. Mailloux, Dr. M. I. Pupin.

The appointments were announced formally by letter from the Secretary, under date of June 26, 1900.

At the close of the opening session of the Electrical Congress, in Paris, on the 18th of August, President Hering called together in conference all that could be found of the members of the American Institute of Electrical Engineers there present. On information that Dr. Pupin and Dr. Goldsborough would not be present, the President appointed Dr. F. B. Crocker and Mr. B. J. Arnold, as delegates in their places. The delegation then elected Dr. Crocker as Chairman, and Mr. Mailloux as Secretary. Attention was called to the fact that President Hering and Dr. Kennelly were also official delegates of the U. S. Government, and that the United States would be allowed only three votes, same as France, England, Germany, and other large countries (all smaller countries being limited to two or even to one) in the "Chamber of Official Delegates," or that portion of the Congress which was alone to pass upon international ques-

tions, such, for instance, as the adoption of new units. It was decided that the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS should preempt and control at least two of these three votes, if possible. (It actually controlled all three votes, when the time came.) Dr. Kennelly was unanimously chosen to represent the delegation and the INSTITUTE, before the Congress, in all matters pertaining to units. Mr. Mailloux was chosen to act as interpreter and spokesman for the delegation, when necessary; and he was also appointed as substitute for Dr. Kennelly in the Chamber of Official Delegates, at any and all meetings of said body which might take place after Dr. Kennelly's departure, in case he could not remain in Paris until the close of the Congress. It was also decided that it was desirable to arrange for and to hold, if possible and at an early date, a joint informal conference of the American and English delegations, for the purpose of exchanging views on the question of units, and also, if expedient and practicable, of securing concerted action by the two delegations. The delegation meeting adjourned, subject to call of the chairman of the delegation. It was not found necessary to call any other formal meeting, the delegates being able to confer together before or after or during the session meetings, without difficulty.

It is proper to point out here that the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS had, as a body, virtually committed itself on the question of units and nomenclature, to a certain definite policy, which was set forth in the report of its Committee on Units and Standards, as presented and adopted at the last General Meeting, at Philadelphia, in May, 1900. This Report had been formulated, originally, with the intention that it should serve, if need be, as a formal statement, before the Electrical Congress, of the attitude of the INSTITUTE on the questions of units and nomenclature. A French translation of this Committee Report had been made, and a thousand copies had been printed, which were distributed to all the members, at the opening meeting of the Electrical Congress, and which were also obtainable at all the succeeding sessions. This report was properly regarded by the delegation of the INSTITUTE as constituting the programme of its official policy. The efforts of the delegation were therefore to be aimed at securing international cognizance of and action upon recommendations of this report.

The joint conference with the English delegates took place on Monday, August 20th, and the aforesaid report was there presented for consideration. The discussion to which it gave rise was both long and varied: but the conference nevertheless adjourned without having reached any definite conclusion or understanding regarding joint action on any of the many topics considered. The result was far from encouraging, more especially as much opposition to the adoption of any new units or to any change in nomenclature was brought to light. It was soon found, moreover, that many of the prominent European delegates were unfavorable to the programme of our delegation, and that the task of the delegation would be a difficult if not a hopeless one.

The work of the Electrical Congress was apportioned among five sections, one of which included three divisions, making a total of seven departments; each section having a French president and three or four foreign vice-presidents, among which were three members of our delegation as follows: Dr. Kennelly, in Section I (Methods and Apparatus for

Measurements, etc.); Mr. Mailloux, in Section II, Division A (Production and Utilization of Electricity); Mr. Hering, in Section II. Division B (Electric Lighting). At the first meeting of Section I, Dr. Kennelly was also appointed on the Special Committee on Units (with Prof. Hospitalier as chairman), to consider and report upon the general question and subject of units and nomenclature.

Dr. Kennelly worked very hard, both in committee and out of it, to secure the acceptance and adoption of the measures recommended by the INSTITUTE. It became evident, however, that the propositions or recommendations presented in behalf of the INSTITUTE could not be all reported favorably by the Special Committee of Section I, and that some of them must be sacrificed The official report of this Committee (of which a translation is appended to the present report), gives the recommendations which the committee finally decided to adopt and which its chairman (Prof. Hospitalier), reported to Section I, at the last formal meeting of this Section, in the morning of August 24th. As the text of the report indicates, Dr. Kennelly had been unable to induce the committee to consider the matter of revising or rationalizing the units. He succeeded, however, in securing action favoring the adoption of two units (one for magnetic density, the other for magnetic flux), both of which were on the programme of the INSTITUTE delegation; he secured the recommendation of the name ("Gauss") first advocated by the INSTITUTE for one of these units.

The Special Committee Report gave rise to an animated discussion, before Section I. The adoption of names for the unnamed units, especially for C. G S. units was strenuously opposed by many of the members, including Prof. Mascart, who presided at this meeting of Section I. In the absence of Dr. Kennelly, who had left for America, Mr. Mailloux addressed the meeting and presented the views and arguments of the INSTITUTE delegation in favor of the adoption of the Committee Report. He took occasion, in the course of his remarks, to call special attention to the fact that the "Gauss" was already accepted and recognized by the INSTITUTE; that it was already in practical use in America; that the necessity for and convenience of this unit was generally admitted; and that it only lacked international sanction to pass into universal use; and, finally, that the want of official recognition of these two units might retard, but would not likely prevent, their general use and ultimate adoption. The report of the Special Committee was finally adopted by Section I., each portion or recommendation thereof being separately discussed and voted upon. The vote of the meeting on the question of units had the effect, however, of slightly modifying, or rather of supplementing, the recommendation of the Special Committee Report, so far as one of the units (the unit of magnetic flux) was concerned. The question whether the two new units should be "C. G. S. units," or "practical" units had caused much contention and difficulty, there being partisans on both sides. (Even the INSTITUTE delegates were not all of the same opinion on this question). The Committee Report, therefore, represented a compromise between the factions, on this question, for while it specified the kind of unit (C. G. S.), for which it proposed the name "Gauss," it did not specify the kind of flux unit for which it proposed the name "Maxwell." It merely recommended that a name for "a unit of magnetic flux," whose value was to be defined and fixed

at some future congress. The kind and the value both became "fixed," however, by the motion carried before Section I, which conferred the name Maxwell upon a C. G. S. unit of magnetic flux.

In the afternoon of the same day (August 24th) the general meeting of the official delegates of the various governments took place, according to programme. The three delegates officially representing the United States government on this occasion were all members of the INSTITUTE, namely, Mr. Hering, Mr. Mailloux, and Major Millis (U. S. A.), and consequently all three of the votes allotted to the United States were at our disposal. Your delegation deems it a duty and a pleasure to state that the work done and the results accomplished at this meeting, by these delegates, are highly creditable to the dual constituency which they had the honor to represent. It is due wholly to their efforts that the "Gauss" and the "Maxwell" have become international units. A skillfully planned attempt was made at this meeting to prevent the matter of units from being formally presented before and being acted upon by the official delegates. This strategem, which was part of the tactics of the systematic opposition on the part of certain individuals to the adoption of new units, was both foreseen and foiled by the American delegation. Had it succeeded its effect would have been tantamount to "sidetracking" the two new units, by preventing them from receiving the formal, official consideration of the only portion of the congress which was qualified to give them international character and standing. This is made clear by the explanation that, in the section meetings, there were no restrictions whatever of the voting privilege. All the members voted on all questions; they voted, however, as private individuals solely, and not as national delegates. Hence, any action taken, as the result of a vote in a section meeting, really signified nothing more than an expression of opinion by individuals. This opinion might have a certain significance or weight, according to the prominence or the authority of the individuals influencing its expression. Nevertheless, it could have no international character or value, for the simple reason that the members of certain nationalities preponderated in the attendance at the section meetings. In the chamber of official delegates, on the other hand, the voting privilege was accorded to each nation, in a restricted and definite manner, as the result of an apportionment calculated to give to each nation a fair representation, proportionate with its importance. Hence, any action based on a vote in the chamber of official delegates implied the approval or at least the assent of the nations, especially if the decision were unanimous.

The INSTITUTE delegates felt that the new units would not have had a clear title or proper credential as "international" units, without the formal endorsement or ratification of the chamber of official delegates. It was for this reason that it determined to force the issue, on realizing that the session was about to adjourn *sine die*, without taking official action on the new units Mr. Mailloux, as spokesman for the American delegation, addressed the meeting and called attention to the anomalous position in which the two new units would be placed if the official action of the chamber of delegates were omitted; and he cited, as a precedent, the fact that the "henry" was officially adopted by the chamber of delegates at the Chicago Congress. A long and exciting discussion resulted. An idea of what the American delegation here accomplished may be formed from the

statement that it literally forced the question of units into consideration before the chamber of official delegates; that it moved the formal adoption of the two new units recommended in the Special Committee Report; that it held its ground in a stormy debate precipitated by this motion, and lasting over an hour, at first alone, and for much of the time unaided, and in the face of determined opposition, not only from the delegates, but also from the chairman; and, finally, that it ultimately overcame the opposition and secured the passage of the motion with practical unanimity. It may be added that, having attained its purpose,—the official adoption of the new units—it generously aided its opponents to attain theirs,—the passage of a resolution declaring electrical energy to be "property," and entitled to legal protection as such.

At the closing (general) session of the Congress, on Saturday (August 25th), Mr. Mailloux, speaking for the delegation, took occasion to formally express its thanks in behalf of the INSTITUTE and of the American Electrical Engineers for the cordial reception and the many pleasant courtesies accorded to our members during the Congress by our French colleagues, more especially those having taken part in the organization and management of the Congress; and he extended a hearty invitation to the delegates and electrical engineering bodies of all countries to visit America next year, on the occasion of the Pan-American Exposition at Buffalo.

This session was the last official gathering of the Congress, and with it the work of the INSTITUTE delegation ended.

Respectfully submitted,

NEW YORK, Nov. 21, 1900.

F. B. CROCKER, *Chairman*,
BION J. ARNOLD,
CARL HERING,
C. O. MAILLOUX, *Secretary*,
WM. J. HAMMER.

THE EUROPEAN TRIP OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

SECRETARY'S REPORT.

Although the suggestion that the INSTITUTE should hold a meeting in Europe was made several years ago, there was at the time considerable doubt as to whether a sufficient number could be expected to attend. When the date of the International Electrical Congress of 1900 was announced the Council was of the opinion that this event together with the Paris Exposition would make it possible to organize a joint meeting with the Institution of Electrical Engineers of Great Britain, and on November 22, 1899, a committee of three was appointed, with instructions to ascertain about how many members would attend such a meeting if called. It was at that time thought that twenty-five members would constitute a fair representation. It will be readily understood that it was a difficult matter to unite upon a date which would be acceptable to a very large percentage of the membership. Again, the length of time consumed and the expense of the journey were factors which had to be taken into consideration. It was evident at the outset that no reduction of rates could be obtained, so the members were required to make their own plans as to transportation. The suggestion for a joint meeting was favorably considered by the Council of the Institution of Electrical Engineers and the plan and scope of the meeting were undertaken by it. Past-President Martin, a member of the Committee on Papers and Meetings, being in Europe in April and May, was authorized to make such preliminary arrangements as were necessary on behalf of the INSTITUTE. Through the courtesy of Commissioner Peck and Director F. H. Drake, Mr. Martin was enabled to secure space for headquarters in the Electrical Department of the Exposition Buildings, also permission to hold the joint meeting in the United States National Pavilion. The dates finally fixed upon for the various events were governed by the period selected for the Electrical Congress, August 18th to 25th.

A very complete and interesting programme for the entertainment of our members in London was arranged by the Institution of Electrical Engineers, which was opened in the happiest manner by a river party on the Thames, Sunday, August 12th. Many of our members were already in Paris at that time, but several of them made the trip to London and participated in the welcoming exercises which had been so carefully prepared. The first gathering at Paddington Station, in London, for the Thames trip made up a joint party of seventy, including about thirty representatives of the INSTITUTE. After a railway journey of about an hour, Henley-on-Thames was reached, where three electric launches and one steam launch, gayly decorated with British and United States flags intermingled, awaited the arrival of the electrical engineers. The weather was simply perfect, and the pleasures of the day, eagerly looked forward to, can only be properly appreciated by those who had the good fortune to participate. A preliminary run of ten miles, nearly to Shiplake, was first made, returning to Henley, where a bountiful luncheon had been provided by our hosts at the Red Lion Inn. Before leaving the tables, President Perry, of the Institution of Electrical Engineers, formally welcomed the guests, and proposed the toasts of "The Queen" and "President of the United States of America." He then announced as his invention the plan

of calling upon two proposers and two respondents to the toasts which followed. Mr. Alexander Siemens and Mr. Mark Robinson proposed "Our American Guests." President Hering responded and pleasantly acknowledged the hospitality of our English hosts, in which he was ably seconded by Mr. W. J. Hammer, who made a very entertaining and amusing address. The party then returned to the boats, which started down the river on the main trip of the day. The beautiful English landscape, changing at every turn in the historic Thames, was enlivened by the thousands of pleasure seekers, young and old, of both sexes who were enjoying a day's outing upon the water and along the shores. Probably no other river in the world is so thoroughly utilized for out-of-door enjoyment, and it may be readily understood by those who have witnessed the hearty interest shown, why England has in the past been pre-eminent in aquatic sports. Among the novel and interesting features of the trip was the passage through the locks, where pleasure craft of all descriptions were bunched closely together while passing from one level to another. The river trip ended at Maidenhead, where tea was served at the Thames Hotel. Carriages there awaited the party, and after a few minutes' drive the railway station was reached, and with the return to London a day of unalloyed pleasure was ended.

On Monday, August 13th, various works of interest were visited, the most important, because of its novelty, being the Central Underground Railway, operated by electricity. This is the first instance in London of a transportation line on which no attempt is made to classify passengers and where a uniform rate of fare prevails. The equipment is largely American. Locomotives are used instead of motor cars. The service is good and the tunnel is clean and well ventilated. The stations are conveniently located and accessible. The principal objection appears to be that the facilities are not equal to the traffic during the hours of maximum travel. The power station and one of the sub-stations were visited. The Electrical Standard Laboratory of the Board of Trade, the telegraph department of the General Post Office and the Davies Street Station of the Westminster Electric Light Corporation were also visited by members having special interest in those institutions.

Monday evening our members were entertained at a complimentary banquet by the President, Council and Members of the Institution of Electrical Engineers at Princes' Restaurant, Piccadilly. The perfect arrangements which were so apparent on the previous day were predominant on this occasion, and the best of feeling prevailed, largely induced by the excellence of the dinner. Many ladies from England and the United States were present and added greatly to the enjoyment of the evening. The chair was occupied by President Perry, who proposed the toasts of "The Queen" and the "President of the United States." Following the precedent established at the Red Lion Inn luncheon, the President called upon Messrs. H. H. Cunynghame, C.B., and J. S. Raworth to jointly propose the "United States," which was responded to by President Carl Hering, Past-President F. B. Crocker and Mr. C. O. Mailloux. Secretary Pope and Mr. W. M. Mordey were invited to propose the toast of "Electrical Engineering," to which Dr. Silvanus P. Thompson and Past-President A. E. Kennelly responded. In conclusion, Mr. H. Ward Leonard proposed the health of President John Perry, who in reply complimented

Secretary McMillan very highly upon the excellent manner in which he had made all the necessary arrangements, to the entire satisfaction of all.

Tuesday, August 14th, was devoted to a visit to the Government Dock Yard at Chatham. The party assembled at Victoria Station and, after a railway trip of about an hour, was driven to the Yard, and placed under the guidance of Major G. A. Carr, R.E. The various objects of interest visited included the latest type of ironclad, the department of electrical equipment, and the training school of the signaling corps, which included an exhibit of the heliograph, which proved of such important service in the South African war. The visiting members were entertained at luncheon by the Royal Engineers Club, Maj. Gen. Sir Thomas Fraser, K.C.B., C.M.G., R.E., presiding. Later in the afternoon they were the guests of Lady Fraser, at a lawn party.

A joint committee was formed of representatives of both the Institution of Electrical Engineers and the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS to take charge of the preliminary arrangements and details of the Joint Meeting at Paris. This committee was made up as follows;

Representing the I. E. E.	*Representing the A. I. E. E.*
JOHN PERRY, F.R.S., President,	CARL HERING, President,
W. E. AYRTON, F.R.S.,	WILLIAM J. HAMMER,
H. H. CUNYNGHAME, C.B.,	A. E. KENNELLY,
R. K. GRAY,	C. O. MAILLOUX,
W. M. MORDEY.	R. W. POPE.

On Wednesday, August 15th, the combined British and American party assembled at Charing Cross Station and started for Paris at 10 A.M., arriving at about six o'clock. There they again separated according to the hotel arrangements they had made.

Thursday, August 16th, the joint meeting, which was officially presided over by President Perry, of the Institution of Electrical Engineers, and President Hering, of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, was held at the United States National Pavilion, quai d'Orsay, 140 engineers being present. The topic presented for discussion was "The Relative Advantages of Alternating and Continuous Currents for a General Supply of Electricity, Especially with Regard to Interference with Other Interests." The discussion was opened by Mr. Ferranti and continued by Mr. Bion J. Arnold, Sir William H. Preece, Dr. A. E. Kennelly, Prof. W. E. Ayrton, M. Desiré Corda, Dr. F. B. Crocker, Mr. W. M. Mordey, Mr. C. O. Mailloux, Dr. Silvanus P. Thompson and Mr. H. Ward Leonard. A complete, revised stenographic report of this discussion appears in the TRANSACTIONS. After the close of the discussion, Messrs. Hospitalier, Webber, Gavey and Hering gave brief descriptions of the most interesting electrical exhibits, and in the afternoon several parties were formed, and were conducted through the Exposition by those who were familiar with the exhibits.

It having been determined by the members who were present in Paris to tender a reception to the officers and members of the Institution of Electrical Engineers and their French colleagues, a committee consisting of Messrs. Hammer, Mailloux and Pope, acting with the President, undertook to make the necessary arrangements. The only available date appeared to be Monday, August 20th, Commissioner Peck extended the

courtesy of the United States National Pavilion for that purpose All arrangements were made after the adjournment of the meeting on August 16th. About three hundred invitations were issued, and the reception appeared to be a success. The attendance was one hundred and eighty, including representatives from most of the European nations.

On Friday, August 17th, by special invitation of Mr. Clerault, Chief Engineer of the Western Railway of France, the members were afforded an opportunity of visiting its interesting three-phase power station and other features of its electrical traction work. The arrangements for this trip were made by Mr. Coster, of the Westinghouse Electric and Mfg. Co. A "five o'clock tea" tea at the British Royal Pavilion followed, where Colonel and Mrs. Jekyl received the members with true English hospitality. The use of this Pavilion was given by H.R.H. the Prince of Wales and the British Royal Commission.

On Wednesday, August 22d, the President and Council of the Institution of Electrical Engineers, by the kind permission of H. R H. the Prince of Wales and the British Commission, gave a reception at the British Royal Pavilion, which was largely attended and was a very interesting occasion.

On Saturday, August 18th, the International Electrical Congress convened, at which the INSTITUTE was represented by the following delegation: Dr. F. B. Crocker, Chairman, Bion J. Arnold, W. J. Hammer, Carl Hering, A. E. Kennelly and C. O. Mailloux.

Although the work of our delegation is reported elsewhere, it is a pleasure to state briefly that while its members did not accomplish all that they hoped for, yet they really did very well, as there was at one time a fear that their efforts would all be in vain. Through the preliminary work of Dr. Kennelly, and the successful presentation by Mr. Mailloux of the INSTITUTE's case in the Chamber of the Official Delegates of the various governments officially represented, the main portion of the suggestions reported by the Committee on Units and Standards was finally officially adopted by the Congress, as shown in the formal report of the delegation.

The Congress adjourned on August 25th, and was followed by a banquet the same evening on the Eiffel Tower. On this occasion nine different nationalities were represented, speaking eight different languages, which led a gentleman present to remark that the Eiffel Tower had been converted into a veritable "Tower of Babel."

Respectfully submitted,

RALPH W. POPE, *Secretary.*

APPENDIX.

ACTION OF COMMITTEE ON UNITS.

INTERNATIONAL ELECTRICAL CONGRESS, PARIS, AUGUST, 1900.

The appointment of this committee was proposed by Prof. E. Hospitalier at the first session of Section I, August 20, 1900.

Prof. Hospitalier was appointed chairman, with power to choose and appoint the full committee. The committee was made up as follows:

Prof. W. E. AYRTON,	Great Britain.
Prof. M. DE CHATELAIN,	Russia.
Prof. DORN,	Germany.
Prof. E. GERARD.	Belgium.
Prof. L. LOMBARDI,	Italy.
Dr. KENNELLY,	United States.
Mr. DE FODOR,	Hungary.
Mr. DE HOOR TEMPIS,	Hungary.

TEXT OF REPORT.

(Translation.)

REPORT TO M. THE PRESIDENT OF SECTION I.

At its meetings of August 21st and 22d, 1900 the Committee on Units, appointed by the First Section of the International Congress of Electricity adopted the following conclusions:

The Committee shall take into consideration only propositions whose nature does not involve any modifications in the decisions of the previous Congresses.

The Committee does not believe that there is any actual necessity of giving names to all the electromagnetic units.

Nevertheless, in view of the use of practical measuring apparatus giving directly the magnetic field density in C. G. S. units, the Committee recommends attributing the name of "Gauss" to this C. G. S. unit.

The Committee proposes to attribute the name of "Maxwell" to the unit of magnetic flux, whose value is to be defined ulteriorly.

Dr. Kennelly, in the name of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, withdraws the propositions made concerning prefixes and the rationalization of electric and magnetic units.

PARIS, August 22, 1900.

E. HOSPITALIER, *Chairman.*

LIST OF INSTITUTE MEMBERS AND FRIENDS AT LONDON AND PARIS

AUGUST 12-25, 1900.

Adamson, D.
Arnold, B. J.
Ball, W. D., and Mrs. Ball
Bernard, E. G., and Mrs. Bernard
Bradley, C. S., and two sons
Brown, W. D.
Buckingham, C. L.
Clark, W. J.
Coster, M.
Crocker, F. B.
Donner, W. H.
Doubt, Thomas E.
Edmands, I. R.
Ganz, A. F.
Garfield, A. S.
Hammer, W. J.
Heinrich, R. O.
Henry, I. W., Mrs. Henry and son
Hering, Carl
Hollister, J. M.
Kennelly, A. E.
Lansingh, V. R.
LeBlanc, Chas
Leonard, H. Ward, and Mrs. Leonard
Lloyd, Herbert
Lloyd, R. McA.
Lohmann, R. W. and Miss Lohmann
Macfarlane, Alex.
McVey, W. D., Wichita, Kan.
Mailloux, C. O., and Mrs. Mailloux
Millis, Major John, and Mrs. Millis
Mordey, W. M., and Mrs. Mordey
Mix, E. W.
Mullin, E. H.
Oolgardt, J. J.
Olivetti, C.
Phillips, L. A.
Pope, R. W.
Potter, Henry Noel
Preece, Sir W. H.
Smith, Jesse M., and Mrs. Smith
Smith, Oberlin, and Mrs. Smith
Stephens, Geo.
Swan, J. J.
Thompson, S. P.
Thurnauer, Ernst
Townsend, Fitzhugh
Weaver, W. D., and Mrs. Weaver
Welles, Francis R.
West, Julius H.
White, J. G., Mrs. White and son
Zalinski, Capt. E. L.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, September 26th, 1900.

The 146th meeting of the INSTITUTE was held this date at 12 West 31st Street, and was called to order by President Hering at 8:20 P. M.

THE SECRETARY:—At the meeting of the Executive Committee this afternoon it was decided to hold our monthly meetings hereafter on the fourth Friday of each month instead of the fourth Wednesday. This change was brought about for two reasons. One is that sometimes there is difficulty in getting papers ready on account of the half holiday on the Saturday preceding; but the most important one is that we have found upon inquiry that very often we might have the pleasure of the attendance of members from out of the city who can hardly come during the middle of the week, but who could come on Friday and have Saturday and Sunday to return home. This change of date of course will be given on all the notices which go out before the meetings as usual, and you will be reminded of the fact of the change.

It was also arranged, although this is entirely unofficial, that on the night of the meeting as many as possible as are obliged to take their dinner in the city, will arrange to meet at the same restaurant, and the announcement of the dinner and time will be given on the postal cards. This will be entirely distinct from the meeting, and has been done for the reason that it is for the benefit of members who may thus get together in a social way before the meetings whenever possible.

THE PRESIDENT:—We will now proceed with the reading of the paper of the evening. The paper is by Prof. Henry S. Carhart, of the University of Michigan, on the "Imperial Physico-Technical Institution in Charlottenburg." As Prof. Carhart is not present the paper will be read by Dr. Sheldon.

[See page 469, August and September issue.]

Discussion.

The President:—The subject is now open for discussion. It is unfortunate that Prof. Carhart is not present to answer questions, but it would nevertheless be interesting to hear the views of the members present on the subject of the paper. I had the pleasure of visiting this Reichanstalt only about a week ago, and if I can answer any questions I will be glad to do so; my visit was only a very short and hurried one.

I am very glad that Prof. Carhart presented this paper to the Institute, and that he brought out so forcibly in the last section, the need of a similar one in this country. It is certainly humiliating for us in this country to have to go to a foreign institution to have our instruments standardized. There is no reason at all why we should not do exactly the same kind of work here. The expense of conducting this creditable institution, seems to me to be exceedingly small. It is also somewhat humiliating for us that the Weston standard cell, which was invented here, was not appreciated by the world until after it had been investigated by the Reichsanstalt. The same is true of manganine, which now seems to be the standard resistance material in the Reichsanstalt; it seems, in fact, that the manganine standard resistances in that institution are depended upon more than the mercury ohms.

The Reichsanstalt, as Professor Carhart has described to us, is divided into two quite distinct departments, the one for research and the other for what might be called commercial standardization. Prof. Carhart in his paper puts more stress on the first department, that is, the department for research. As a matter of fact, however, the second department is by far the larger. I found that, as far as labor and expenditures are concerned, they stand about as one to three; that is to every man in the research department, there are three men in the standardizing department; the expenses, it seems, are about in the same proportion.

I was interested in the standard of light which that institution has adopted, the Hefner amyle-acetate lamp. They seem to be quite well satisfied with it now, and say that it is more accurate as a standard than the usual measurements that are made with it on the photometer, and therefore it is a sufficiently good standard. They use it altogether, and it has been adopted in Germany as the standard both by the gas and by the electrical industries. This standard can be reproduced by constructing it according to scale, that is, according to measurements, it does not necessarily have to be calibrated; that is, if constructed exactly according to specifications one can be sure that it will give one candle without the necessity of calibration; for very accurate work they are calibrated by the Reichsanstalt. In our country we seem to have no real standard of light. It seems that at one of the large lamp factories in our country, the standard used was handed down through many years, in the form of incandescent lamps.

If we in this country should start a similar institution, I think it would be better to lay more stress on the second department of the Reichsanstalt, that is, the calibrating department, than on the research department, at least at first. I think the first department should follow the introduction of the second, and not precede it, because the second department will yield results at once, and will supply something which is much needed in this country.

I might add that I inquired whether they preferred the Weston cell to the Clark cell, and I found that they not only preferred it, but found it to be very much better. It seems that the Weston cell is now replacing the Clark cell altogether, due, of course, to the well known fact that the temperature coefficient is negligibly small. It was amusing to notice that nowhere did they call it the "Weston cell," as they did not seem to like to admit that it came from America. It is always called the "cadmium cell" there, although the other is called the "Clark," and not the "zinc cell."

DR. SAMUEL SHELDON:—Mr. President, I think that we as a scientific body, and any other scientific body, would strongly favor the founding in this country of an institution of this character. Certainly, if France, or if England, or if Russia, who are so near to the standards of the Reichsanstalt, can feel that it is necessary for them to found such an institution, we, who are over the ocean, who have such troubles in our Custom Houses, and who have such long delays in getting returns from the other side, ought to favor it. We, however, ought to consider that outsiders, and those who are not interested particularly in science, must be made to take an interest, before the object can be attained, and I hope some action will be taken before long, even further than that which has been already taken, to influence legislation in the proper direction. We certainly need such an institution merely for the calibration of instruments, not considering the idea of a research department. I don't know whether we ought to say that we can find in America the man who would make an institution in this country as renowned as is the Reichsanstalt in Germany. Think of the two men who have been at the head of that institution. Helmholtz was a prominent physician, a foremost physiologist, a superior physicist, in fact, a broad and cultured scientist. He was a man who would conquer anything, and who was especially fitted for this kind of a position. Kohlrausch—I had the pleasure of being his assistant for two years—is a man of the most wonderful scientific imagination, and in addition to that fact he criticises himself unsparingly. He was the most prominent advocate and supporter of the laboratory system of instruction in its early days. I think his little *Leitfaden der Praktischen Physik* was the first book on laboratory physics. Now two such men could not have failed to have brought renown to the institution with which they were

connected. I do not question but that we might find somebody who would do the same for us, if he were not hindered because of our methods of legislation and government.

That we have a need for some bureau of unquestioned authority has come to my attention in some work which I have done for two different companies along almost the same lines. The products which they turned out did not differ from each other to any great extent, not much over a tenth of a per cent., but the products of the one company differed by about two per cent. from the products of the other company. Their supposed standards, to which they referred, were not multiples or submultiples of the same unit.

Dr. Charles Avery Doremus:—If an associate may be allowed to speak on this question, I happened the other day to pick up some of Sir Humphrey Davy's works, and in an address before the Royal Institution in London he urged that funds be appropriated for original research. He claimed that the nation which owed its progress to scientific endeavor would never have its citizens suffer the humiliation of slavery; that "science for its progression requires patronage, but it must be a patronage bestowed, a patronage received with dignity." I have tried to quote some of his words. Surely nothing could be more dignified for the promotion of scientific research than that the nation should be the patron, and nothing could subserve the purposes of what has been contemplated by this paper better than to have the Government of the United States not imitate necessarily the Reichsansalt or bureaus of other Governments, but establish something of its own on lines peculiarly original, though duplicating perhaps some work of others. I would like to say as a chemist that considerable advance has been made for the standardization of chemical instruments. We have been at work through committees and the like for some years past, and we are now having numbers of vessels standardized at Washington by the Government, a small fee being paid for the same, and I am under the impression that this bill of Secretary Gage's contemplates the union of all such calibration methods. When we consider how largely our chemical industries have developed in the last few years, how enormously they are going to develop in the next few, how absolutely essential it is to have accurate instruments for measuring solutions, for verifying weights, for making all sorts of computations, it is quite evident that there is a field in that direction which is quite as important as the electrical field. I am under the impression that Congress has already been memorialized from the chemical side of the scientific professions, and if the different institutes and different scientific societies of this country were to act in unison, I am very certain that very fruitful results would issue, perhaps in the next session of Congress.

MR. TOWNSEND WOLCOTT:—I want first to speak about those lamps that the Navy Department sent over. As I understand, Mr. President, you say that the amyle-acetate lamp is exceedingly accurate; but is it easy to use in calibrating electric incandescent lamps?

THE PRESIDENT:—It is easier to use than any other standard.

MR. WOLCOTT:—The Navy Department had some lamps, I think ten primary standards and twenty secondaries, and a lot more tertiary standards. At first they had intended to have them all standardized by comparison with the amyle-acetate lamp, and then after they got them they were to use the primary standards only to standardize the secondary, and the secondary only to standardize the tertiary. The tertiary standard was the one they would really use in daily work, so as to preserve their primary standards as long as possible. But the Reichsanstalt said that they could not do them that way; at all events, it would be entirely too much work; they would compare one lamp with the amyle-acetate standard and compare all the others with that. It seemed to indicate that they found it a great deal more work to compare an incandescent lamp with the amyle-acetate lamp, than to compare one incandescent lamp with another. The amyle-acetate lamp and the incandescent lamp are not exactly the same color. With two incandescent lamps of exactly the same color—that is, the same temperature—you can set the carriage of the photometer, if it be Lummer-Brodhun type, to a single millimeter every time, set it three or four times, and get the same result; whereas, if there is the slightest difference in the color you cannot do that.

Then in regard to standardizing instruments in this country, the Signal Corps here in New York had a Wheatsone bridge, which was rather old, and they wanted it standardized, and sent it to the Coast Survey. It was standardized. That is, each coil was measured, but they had no facilities for adjusting the coils. It is a little better to know when a coil is out, to know just what it is than not to know at all, but it is not nearly so good as having it adjusted so that it is right. It is somewhat humiliating that we have in this country no government institution for adjusting instruments accurately, and the advantage that some such institution as the Reichsanstalt would confer if we had one here is manifest.

DR. LOUIS BELL:—As Chairman of the National Electric Light Association Committee on standardizing electric lamps, I would say that the question regarding standard of light is one of direct interest. The committee has definitely accepted the amyl acetate standard as the ultimate standard to which light should be compared; but it is a fact that owing to the slightly reddish cast of the amyl-acetate lamp, comparisons are by no means easy, and I am not at all surprised that the Reichsanstalt preferred

to compare one or a few lamps rather than standardize a large number. It is, however, a wonderfully satisfactory standard to use aside from the question of the slight difference in color. The difficulty which our committee has found is not in settling upon methods or anything of that sort, but agreeing on any one systematic way of rating incandescent lamps, which will not cause a cat and dog row among the lamp manufacturers, who, for the most part, I am earnestly persuaded, are intent on turning out a good product, but are a little bit cautious about admitting any particular method of rating, which might at the present time or some future time have an unfavorable influence on the rating of some lamps. I think, however, that in the last year or two, manufacturers have been coming to realize more and more the meaning of a definite standard, and I feel sure that that difficulty is going to vanish. The committee is now pegging away at the problem, making arrangements to produce some primary standard lamps and supply them, but the difficulty which has been met so far has been very largely commercial, it being very hard to settle upon a rating of lamps, quite aside from the scientific problems involved in standardizing, which will not be a source of constant rows in the case of those who make and also those who use lamps. I think the question is settling itself very satisfactorily, and I have no doubt that by next year at the coming meeting of the National Electric Light Association the committee will be able to bring in a final report, and will also able to furnish carefully standardized incandescent lamps to all who desire them.

THE PRESIDENT:—In reply to a question which Mr. Wolcott brought up, I would say that the Reichsanstalt uses the amyle-acetate lamp only as a primary standard, for occasionally standardizing incandescent lamp secondary standards. When they make measurements of electric lamps, they always use these secondary standard incandescent lamps, and bring the voltage to the proper amount. The incandescent lamps are used far below their rated candle power, that is, at a much lower voltage than the normal. In that way they get a light of about the same color as that of the amyle-acetate lamps; the comparison then becomes easier and more accurate, and the standard lamps last longer. If I remember correctly, one of their standard lamps used in this way, has run for ten thousand hours, and is still of exactly the same candle power it was in the beginning.

CAPTAIN SAMUEL REBER:—I know that we all agree upon the establishment of a Standardizing Bureau in this country. The question which arises is: what action shall the INSTITUTE take to further the establishment of this Bureau? I know from the results of correspondence and conversation with officials of the Coast and Geodetic Survey in Washington that a bill, drafted by them, was sent by Secretary Gage to both the Senate and House of Representatives, and was introduced as House Bill No. 11350, on May 5, 1900, and as Senate Bill No. 4680, on May 14, 1900. The

copy I have shows that the measure is very complete and amply covers the ground.

THE SECRETARY:—I have a copy of it at the office, and I was looking it over to-day. In addition to the bill, it goes into details as to the staff and the salaries and number of employees, and also in addition to that letters from prominent men in various lines throughout the country, making quite a complete document that was printed by the government.

CAPTAIN REBER:—After an extended hearing before the Committee on Coinage, Weights and Measures of the House, the bill was favorably reported, but owing to the press of business at the close of the session it failed to pass. I would like to ask if the INSTITUTE cannot take some action in the way of urging its passage. If a committee were placed in charge of the matter they could decide whether it is advisable to take it up on the lines of the bill, and if so, to then act on the matter.

THE SECRETARY:—The Council has already appointed a committee, and one or more members of it have appeared before the Congressional Committee at Washington in advocating this measure. At a meeting of the Executive Committee to-day the Chairman was called upon to make a report as to what further steps were necessary, the idea of the Executive Committee being that it would perhaps be advantageous to enlarge the committee by putting on a member in each State, as far as we could, or something of that kind, in order to carry out this line of work in bringing the attention of Congressmen and Senators in various parts of the country to the importance of this measure.

DR. DOREMUS:—I would say that the American Chemical Society which is a national society, has taken this up, and that the different agricultural stations throughout the United States are highly interested in the matter, and that the Department of Agriculture, especially the chemical division of the Department of Agriculture in Washington, is extremely interested, and has pushed the matter quite some, so that there is a very good chance for proper influence to be brought to bear to show the necessity and the needs of the manufacturing community, and the scientific community, particularly, to get this bill properly presented to Congress, and I believe that our national societies would gladly co-operate.

MR. E. H. MULLIN:—I was speaking the other day to a Congressman, who is now serving his sixth term in Washington, about this very bill, and he told me that if deputations were to go down in support of the bill, it would be of the best service in January next. He also told me that the most practical means of urging this bill upon the various Congressmen was for each member of each institution such as this, to write to his local Congressman from his own home and bring that pressure to bear, and he also said a third thing, and that was that the Washington officials should keep as much in the background as possible.

He is in favor of the bill himself, and will do his utmost to help to pass it.

MR. FREDERICK V. HENSHAW:—It seems to me that there are some important factors in this question which possibly have not been brought up. I came in a little late, perhaps they were mentioned before. I do not wish in any way to belittle the effect of societies and scientific institutions on legislation, but I think they need a little more backing if anything is going to be accomplished satisfactorily. A good many societies have been working on the patent office question for a good many years, and I do not see that they have gotten any very satisfactory fruit. Now, if this Government Bureau is to be of great advantage to the manufacturers of this country, as I think everybody concedes it would be, there is one factor. If you can get the rich corporations and the men of influence interested in manufactures to use their weight, that would be one thing. Then there are the army and navy. I notice in Prof. Carhart's paper he speaks of a communication from the United States Navy in regard to standardizing. The navy is working towards various standards both in mechanical and electrical engineering features, and the Army of course is doing the same thing to a somewhat less extent. Now, if a bureau could be established which could fix the standards for both the army and navy, it would simplify a great many things, and be of great benefit, and if the engineer officers of those two Government departments were strongly in favor of this I think it would be a very great factor in the establishment of such a bureau.

CAPTAIN S. REBER:—In answer to the suggestion just made, I may say that as far as the army and navy are concerned, I know they are both very much interested in the establishment of this bureau.

As a result of practical experience I agree with the statement that a resolution of a society does have the weight with Congress that it perhaps should. Congressmen, as a rule, do not take interest in the advancement of pure science or its application, but are much more responsive to personal pressure than to a series of formal resolutions from a technical society.

MR. MULLIN:—How would it do to have a circular letter sent to all the members of our INSTITUTE asking each member of the INSTITUTE to write a letter to his local Congressman in support of this measure? As I have heard about the measure, it is this way: It so nearly passed at the last session that it would pass with proper pressure in the short session, but it is one of those measures that if it goes over for a year or so becomes one of the regular annuals in the House that they always think of passing, and never pass. You have an excellent opportunity now, and perhaps as good an opportunity will never occur again.

THE PRESIDENT:—This matter is in the hands of a Committee of the INSTITUTE; it came up to-day at the Council meeting, and

it was decided to ask the Chaiaman of that Committee to report on what the Committee considered to be the best action for the INSTITUTE to take. Any members having any suggestions to make, would do well to communicate with this Committee of the INSTITUTE.

DR. FRANCIS B. CROCKER:—I visited the Reichsanstalt some time ago, but the matter is so forcibly stated in Professor Carhart's paper, that there is very little to add in the way of an argument, and apparently the matter of bringing it favorably to the attention of Congress is in the hands of a committee. It seems to me there is not very much to be done. It appears to be the unanimous opinion of all our members here, and I think of the absent members, that it is a very desirable thing to bring about. In fact, it is so clearly true, that it is hardly necessary to add any testimony. The question has been up for a long time. I remember when Dr. Mendenhall was Superintendent of the Coast Survey he made a beginning in this movement to establish an electrical bureau or electrical department in the Bureau of Weights and Measures. I might add that this Government is not so very deep in barbarism as some of the speakers would imply. The Bureau of Weights and Measures has standards that are as good as those possessed by any country, and it is perfectly able to verify or to compare those standards with others that may be submitted to it. The Coast Survey of this country is a scientific department which has done most admirable work. In the measurement of base lines, for example, it is unexcelled, and its pendulum determinations of gravity are fully equal to those done anywhere else. So we already have started and started many years ago in this direction. It only remains to give additional assistance and money, to carry the work into the electrical field especially, and the chemical as well, in order to have a scientific department in Washington which would be very creditable. I think myself that the influence of the various national bodies, if brought to bear directly—if the committee report contained the official endorsement of the various bodies—I am sure that it would have weight. A Congressman is also affected by personal influence; but in a matter of this kind it is largely a question of whether it is a desirable thing to do or not. It is not a personal matter; it cannot be made a personal matter, and it seems to me that this body and other bodies should put themselves squarely on record, and that record should be, if possible, placed before the Congressional Committee, and attached to the bill in some form, and I am very sure it would have some weight. Of course adding to that the personal influence of the various members and bringing pressure to bear on the local Congressman would still further influence the result. But it seems to me the thing is so very desirable, that it is only necessary to bring it up to have it pass.

THE PRESIDENT:—If there is no further discussion, I will show briefly how the spherical candle power of incandescent lamps is measured at the Reichsanstalt. It is quite ingenious, but it may not be new. The lamp is placed in a horizontal position, in the axis of the photometer, and is stationary. Around the lamp are revolved two flat mirrors making a certain angle with the axis. The direct light is cut off by a black screen. The light which is measured is that which falls on the mirrors, and is reflected into the photometer. The advantage of course is that you do not revolve the lamp, and the filament is therefore always in exactly the proper position. In this country I believe the lamp is generally revolved. With high voltage lamps the filaments are rather long, and if you revolve such a lamp rapidly enough to get no flicker in the photometer, the filament is apt to bend over to one side, due to centrifugal force.

[Adjourned.]

[COMMUNICATION RECEIVED AFTER ADJOURNMENT.]

DR. A. E. KENNELLY:—There can be no doubt as to the great importance of the work which the Charlottenburg Institution has carried on through the last decade. The researches which have been carried on there have been of great value, not only to Germany, but also to the whole scientific world. The work of such an institution fosters scientific inquiry, indirectly promotes justice and morality, and directly aids ingeneering. There can be no doubt that such an institution in America would be a matter of national importance and advantage. Considering the enormous value to modern civilization of scientific knowledge in general and of engineering, or technical knowledge in particular, it is difficult to imagine a more useful type of institution than the Reichsanstalt. No public gift could be of greater public advantage than such an institution, unless, perhaps, a hospital or a university.

The founding and endowing of such an institution by Government would naturally depend for its economic justification upon the more purely utilitarian aspect of such a bureau as a national industrial asset. It would seem that, from this standpoint also, the expense incurred in such endowment would be justifiable. In the first place, one of the duties of such an establishment would no doubt be the care and comparison of all physical standards, such as those of length and mass, and which already require and receive appropriation from the national coffers. The institution would be, therefore, but a natural extension of a bureau already existing at Washington. In the second place, the institution would, if properly administered, be reimbursed of a large porportion of its expenses in the fees which it would receive for the comparison and standardization of chemical and physical apparatus for industrial purposes. The saving to the

community in expenses which are now rendered necessary by the want of a national standardizing bureau, would more than pay for the deficit, on any reasonable scale of expenditure. All this, however, naturally rests upon the assumption that such an institution was conducted and controlled on civil-service principles, as distinguished from political principles. If the bureau became a mere political office, a splendid opportunity for the fostering of knowledge, skill, accuracy, engineering and trade would be more than wasted.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, October 24th, 1900.

The 147th Meeting was held this date at 12 West 31st Street, and was called to order by President Hering at 8.20 P.M.

THE SECRETARY:—At the meeting of the Council this afternoon it was voted to hold the next General Meeting at Buffalo, and although the exact date was not determined upon it will probably be about the middle of August. At the same time the question of inviting foreign societies was considered, in return for the courtesies extended to the INSTITUTE during the present season, and a committee of five was appointed to formulate and present to the Council a programme for the meeting and various entertainments next summer. The committee consists of Mr. C. O. Mailloux, Chairman, Mr. Sever, Dr. Sheldon, Mr. Lieb and the Secretary.

At the same meeting this afternoon the following Associate Members were elected:

AYLMER-SMALL, C. SIDNEY	Assistant, Electrical Engineering Department, Columbia University, New York; residence, 52 Franklin Avenue, Passaic, N. J.	F. B. Crocker. Geo. F. Sever. F. Townsend.
BURDICK, IRVING EDWARD	Treasurer and Engineer, Naval Electric Co., 95 Liberty St.; residence, 115 West 49th St., New York.	Chas. W. Price. Ralph W. Pope. F. E. Kinsman.
FOWLER, GEO. W.	Electrical Expert, The C. & C. Electric Co., Westfield, N. J.	John L. Hall. Chas. Hewitt. Theo. Spencer.
GLASS, LOUIS	Assistant General Manager, Pacific Telegraph and Telephone Co., Telephone Bldg., San Francisco, Cal.	J. A. Lighthipe. H. A. Russell. C. W. Waller.
HASSLER, CHAS. T. F.	Electrical Engineer, "Union" Co., Riga, Russia.	C. P. Steinmetz. Ernst J. Berg. Eskil Berg.

HEITMANN, EDWARD JR.	Stanley Electric M'fg. Co., Pittsfield, Mass.	C. C. Chesney. John F. Kelly. F. A. C. Perrine.
PARSHALL, AUGUST	Commercial Engineer, Supply Department General Electric Co., 83 Cannon St., London, E. C.	H. F. Parshall. J. R. Lovejoy. H. M. Hobart.
ROSSI, HAROLD J.	Electrician, Puebla, Mexico.	C. F. Beames. P. H. Evans. C. W. Evans.
RUSTIN, HENRY	Chief of the Mechanical Bureau, The Pan-American Exposition, Buffalo, N. Y.	Geo. F. Sever. Luther Stieringer. T. C. Martin.
SMITH, SAMUEL JAMES	Salesman and Installing Engineer, Crocker-Wheeler Co., Y. M. C. A. Building, Charlotte, N. C.	Fred D. Sampson. Gano S. Dunn. F. V. Henshaw.
STITZER, ARTHUR BOWERS	Draughtsman, Union Traction Co.; residence, 1909 North Camac St., Philadelphia, Pa.	Chas. Hewitt. Minford Levis. R. H. Klauder.
THOMAS, PERCY HOLBROOK	Electrical Engineering Department, Westinghouse E. & M. Company, Pittsburg, Pa.	Chas. F. Scott. L. B. Stillwell. A. J. Wurts.
THOMPSON, WARREN RAY	Assistant in Electrical Engineering Department, J. G. White & Company, 29 Broadway, New York.	R. D. Mershon. H. A. Lardner. J. J. Kennedy.
WALMSLEY, WALTER NEWBOLD	Superintendent of Construction, American Engineering Co., Pomeroy, O.	Chas. Hewitt. C. A. Bragg. Minford Levis.
WEBB, HOWARD SCOTT	Professor of Electrical Engineering, University of Maine, Orono, Maine.	D. C. Jackson. S. B. Fortenbaugh. B. S. Lanphear.
WHEILDON, LOUIS B.	Contractor and Expert, 1010 Exchange Building, Boston, Mass.	H. C. Spaulding. C. K. Stearns. Ralph W. Pope.
WHITEHEAD, JOHN B., JR.	Associate in Applied Electricity, Johns Hopkins University, Baltimore, Md.	L. B. Stillwell. C. T. Hutchinson. Ralph W. Pope.
WIESELGREEN, CARL EMIL	Yonkoping, Sweden.	Ernst J. Berg. W. I. Slichter. C. P. Steinmetz.
WOLF, LEE H.	Contracting and Engineering, Honolulu, H. I.	Geo. P. Low. F. F. Barbour. A. E. Brooke-Ridley.

Total, 19.

Vice-President Lieb then took the chair, and the President read his Inaugural Address.

[See October issue, p. 529.]

Following the Inaugural Address, Mr. F. W. Roller exhibited and described the "Column Type of Indicating and Recording Volt and Ampere Meters," after which the meeting adjourned.

Donations to the Library of the American Institute of Electrical Engineers.

The following donations have recently been made to the Institute Library:

Edward Caldwell:
Proceedings of the Royal Society of London. 1800–1886. Vols. 1–41.

Electrical Review:
Electrical Engineering. 1893–1898. Vols. 1–11.
Electricity. 1891–1899. Vols. 1–17.

Electrical World and Engineer:
Journal of the Telegraph. 1867–1881. Vols. 1–16.
The Telegrapher. 1864–1876. Vols. 1–12.
La Lumière Electrique. 1879–1884. Vols. 1–14.
Scientific American. 1859–1886. Vols. 1–55. (Vol. 10, 1864, lacking.)
Scientific American Supplement. 1876–1886. Vols. 1–22. (Vol 13, 1882, lacking.)
Street Railway Gazette. 1886–1893. Vols. 1–9.
Electric Railway Gazette. 1895–1896. Vols 13 and 14.
London *Electrician.* 1878. Vol. 1. 1882–1885. Vols. 10–15.
London *Electrical Review.* 1885–1886. Vols. 16–19.
Journal of the Society of Telegraph Engineers. 1878–1879. Vols. 2–4. 1879. Vol. 8.

C. O. Mailloux:
$275.00 for the purchase and to defray cost of binding a complete set of *Comptes Rendus de L'Academie des Sciences.* 1885–1897. Vols. 1–125.

T. C. Martin:
"Evidence in the Bain Suit." U. S. Circuit Court, Eastern District, Penna. B. B. French *et al. vs.* H. J. Rogers *et al.* Philadelphia, 1851.
Personal copy of Prof. S. F. B. Morse, copiously annotated in his own handwriting.

W. D. Weaver:
Du Moncel: "Exposé des Principales Applications de l'Electricite." 5 Vols. Paris, 1878.
A valuable account of the Art covering the period to 1873.
Nollet, L'abbe: "Recherches sur les Causes Particulière des Phenomènes Electriques." Paris, 1749.
The author lays down an electrical theory, according to which the cause of electrical phenomena is the "effluence and affluence" of a subtle fluid everywhere present. When a body is electrically excited it emits fluid of one sign and attracts fluid of another sign. Some interesting experiments with vacuum tubes are described.
"Rapport fait à la Classe des Sciences Mathematique et Physique de la Institut National sur les Experiences du Citoyen Volta." Lu le 11 frimaire, an 10 (December 2, 1801).
An official report, printed for the Institut, of a committee before whom Volta appeared, consisting of Laplace, Coulomb, Charles, Biot, Monge, Foucrov, Vauquelin, Pellatan, Brisson, Guyton and Sabathier. In an Appendix the phenomena of the Volta pile are made the subject of mathematical analysis.
Science. 1880–1884. Vols. 1–8.
Dredge: "Electric Illumination." Vols. 1. London, 1882.

Townsend Wolcott:
Dredge: "Electric Illumination." Vol. 2. London, 1884.

OBITUARY.

JOSEPH CLEMENT, who was elected an associate member of the INSTITUTE April 26th, 1899, was killed in the battle of Zand River, a few miles north of Bloemfontein, in June, 1900. Mr. Clement was born in Oakland, California, and was 28 years of age at the time of his death. He was educated in California, and went from there in 1894 to South Africa, where he joined the electrical staff of the De Beer's Consolidated Mines, Ltd., in Kimberley. Leaving there shortly afterward he became connected with Messrs. Reunert & Lenz, Electrical Engineers in Johannesburg, and shortly afterward was appointed Electrician to the Rand Mines, Ltd., and the Crown Reef Gold Mining Co., Ltd., both of Johannesburg. In the latter capacity he had much important work under his immediate control, and carried out electrical undertakings of considerable magnitude for the two companies mentioned. Upon the outbreak of war between England and the South African Republic Mr. Clement volunteered, and was appointed Lieutenant in the Railway Pioneer Regiment, a volunteer corps organized by the late L. I. Seymour, an American of great prominence and distinction in Johannesburg. Mr. Clement and his commanding officer, Major Seymour, both met their death at one of the engagements which occurred along the line of communications after Lord Roberts' march to Pretoria. Both fell fighting in the front rank of their command. Mr. Clement had been married only a short time before to Miss Josephine Webber, daughter of Mr. George E. Webber, General Manager of the Rand Mines, Ltd., who, with his infant daughter, survives him.

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JOURNAL OF THE INSTITUTION OF ELEC. ENGS, London.
AMERICAN MACHINIST, N. Y.
ENGINEERING MAGAZINE, N. Y.
CASSIER'S MAGAZINE, N. Y.
ENGINEERING NEWS, N. Y.
ENGINEERING RECORD, N. Y.
STREET RAILWAY JOURNAL, N. Y.
STREET RAILWAY GAZETTE, N. Y. and Chicago.
ELECTRICAL ENGINEERING, Chicago.
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L'ECLAIRAGE ELECTRIQUE, Paris.
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L'ELECTRICIEN, Paris.
JOURNAL OF THE FRANKLIN INSTITUTE, Phila.
SCIENTIFIC AMERICAN, N. Y.
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Contents of Vol. XVII, 1900.

Notes on Electric Traction Under Steam Railway Conditions. By Edward C. Boynton. Notes on Single-Phase Induction Motors. (Illustrated.) By Charles P. Steinmetz. A New Method of Tracing Alternating Current Curves. (Illustrated.) By Fitzhugh Townsend. The Evolution of Safe and Accurate Fuse Protective Devices. (Illustrated.) By Joseph Sachs. No. 2, February, 1900. Hysteresis in Sheet Iron and Steel. (Illustrated.) By Arthur Hillyer Ford. No. 3, March, 1900. A Fahrdmeter. (Illustrated). By M. I. Pupin. Expert and Expert Evidence. By J. E. Hyde. A New Transmission Dynamometer. (Illustrated.) By W. E Goldsborough. A Percentage Bridge. (Illustrated). By H. C. Parker. Eddy Current Loss in Transformers. By Fitzhugh Townsend. Wave Transmission Over Non-Uniform Cables and Long Distance Air-Lines. (Illustrated.) By M. I. Pupin. No. 4, April, 1900. Conditions of Electrolytic Corrosion in Boilers. By Samuel Sheldon. A Test of Cables Transmitting Currents for Cable Telegraphy. (Illustrated.) By A. C. Crehore and G. O. Squier. No. 5, May, 1900. The Use of Aluminium Line Wire, and Some Constants for Transmission Lines. (Illustrated.) By F. A. C. Perrine and F. C. Hasm. Nos. 6 and 7, June and July, 1900. The Imperial Physico-Technical Institution in Charlottenburg. (Illustrated.) By Henry S. Carhart. Nos. 8 and 9, August and September, 1900. The Paris Exposition of 1900. Inaugural address by President Hering. No. 10, October, 1900. The Plant of the St. Croix Power Co., of Wisconsin. (Illustrated.) By Henry Floy. The Mechanical Forces in Dynamos Caused by Magnetic Attraction. (Illustrated.) By B. A. Behrend. No. 11, November, 1900 Catalogue of Membership. No. 12, December, 1900.

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